DOCUMENT RESUME

ED 163 988 IR 006 674

AUTHOR	Fielding, J. E.; And Others
TITLE	State Criminal Justice Telecommunications (STACOM). Final Report. Volume III: Requirements Analysis and Design of Texas Criminal Justice Telecommunications Network.
INSTITUTION	Jet Propulsion Lab., Pasadena, Calif.
SPONS AGENCY	Law Enforcement Assistance Administration (Dept. of Justice), Washington, D.C.
PUB DATE	31 Oct 77
NOTE	358p.; Tables may be marginally legible due to small type; For related documents, see IR 006 202, 387, and 610
AVAILABLE FROM	Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (Stock No. 027-000-00698-1)
EDRS PRICE	MF-$0.83 HC-$19.41 Plus Postage.
DESCRIPTORS	*Computer Oriented Programs; *Criminal Law; Data Analysis; Data Collection; Design Needs; Information Needs; *Information Networks; Management Information Systems; Research Methodology; *State Programs; State Surveys; Summative Evaluation; *Telecommunication; Topology
IDENTIFIERS	*Texas

ABSTRACT

Requirements analysis and design for the Texas Criminal Justice Telecommunications Network are provided in this report on the application in the state of Texas of techniques developed by the STACOM project. These techniques focus on identification of user requirements and network designs for criminal justice information on a state-wide basis. Techniques for analyzing user requirements include methods for determining data required, data collection, data organization procedures, and methods for forecasting the volume of network traffic. Network design techniques center around a computerized topology program that enables the user to generate least cost network topologies that satisfy network requirements for traffic, response time, and other specified functions. Appendices include the state level questionnaire and user survey. (Author/CMV)

STATE CRIMINAL JUSTICE TELECOMMUNICATIONS (STACOM) FINAL REPORT

Volume III: Requirements Analysis and Design of Texas Criminal Justice Telecommunications Network

J.E. Fielding
H.K. Frewing
Jun-Ji Lee
N.B. Reilly

October 31, 1977

Law Enforcement Assistance Administration
U.S. Department of Justice

ACKNOWLEDGMENT

It is a pleasure to acknowledge the help received from the entire STACOM team. Special thanks for their many contributions go to the following state and federal officials.

Washington D.C.

Norbert Schroeder	LEAA, NCJISS

Texas

Jim Jones	Criminal Justice Division
Jack Martine	Department of Public Safety
Chief H. W. McFarling	Department of Public Safety
Chief Glen H. McLaughlin	Department of Public Safety
Vernon Strey	Department of Public Safety

FOREWORD

The State Criminal Justice Telecommunications, (STACOM), Project consists of two major study tasks. The first entails a study of criminal justice telecommunication system user requirements and system traffic requirements through the year 1985. The second investigates least cost network alternatives to meet these specified traffic requirements.

Major documentation of the STACOM Project is organized in four volumes as follows:

Title	Document No.
State Criminal Justice Telecommunications (STACOM) Final Report - Volume I: Executive Summary	77-53 Vol. I
State Criminal Justice Telecommunications (STACOM) Final Report - Volume II: Requirements Analysis and Design of Ohio Criminal Justice Telecommunications Network	77-53 Vol. II
State Criminal Justice Telecommunications (STACOM) Final Report - Volume III: Requirements Analysis and Design of Texas Criminal Justice Telecommunications Network	77-53 Vol. III

Title	Document No.
State Criminal Justice Telecommunications (STACOM) Final Report - Volume IV: Network Design Software Users Guide	77-53 Vol. IV

The above material is also organized in an additional four volumes which provide a slightly different reader orientation as follows:

Title	Document No.
State Criminal Justice Telecommunications (STACOM) Functional Requirements - State of Ohio	5030-43*
State Criminal Justice Telecommunications (STACOM) Functional Requirements - State of Texas	5030-61*
State Criminal Justice Telecommunications (STACOM) User Requirements Analysis	5030-80*
State Criminal Justice Telecommunications (STACOM) Network Design and Performance Analysis Techniques	5030-99*

*Jet Propulsion Laboratory internal document

This document, No. 77-53, Vol. III, entitled "State Criminal Justice Telecommunications (STACOM) Final Report -- Vol III: Requirements Analysis and Design of Texas Criminal Justice Telecommunications Network," describes methodologies developed for user requirements studies and for the analysis and design of communication network configurations. It then illustrates the applications of these methodologies in the State of Texas.

This document presents the results of one phase of research carried out jointly by the Jet Propulsion Laboratory, California Institute of Technology, and the States of Texas and Ohio. The work at the Jet Propulsion Laboratory was performed by the Systems Division, Telecommunications Science and Engineering Division, and Information Systems Division under the cognizance of the STACOM Project. The project is sponsored by the Law Enforcement Assistance Administration, Department of Justice, through the National Aeronautics and Space Administration (Contract NAS7-100).

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

APB	All points bulletin
BPP	Texas Boards of Pardons and Paroles
bps	Bits per second
CCH	Computerized Criminal Histories
CDS	Comprehensive Data System
CJIS	Criminal Justice Information System
CRT	Cathode ray tube
DEA	United States Drug Enforcement Agency
DPS	Texas Department of Public Safety
FINDER	Calspan Technology Products, Inc., registered trademark for Fingerprint Detector Readers.
FBI	Federal Bureau of Investigation
ICR	Identification and Criminal Records Division of Texas Department of Public Safety
LEAA	Law Enforcement Assistance Administration
LIDR	Texas License Identification and Driver Registration
MDT	Mobile Digital Terminal
MVD	Texas Motor Vehicle Division
NALECOM	National Law Enforcement Telecommunications
NCIC	National Crime Information Center
NCJISS	National Criminal Justice Information and Statistics Service
NILECJ	National Institute of Law Enforcement and Criminal Justice
NLETS	National Law Enforcement Telecommunications System
OBSCIS	Offender Based State Corrections Information System
OBTS	Offender Based Transaction Statistics
OCCA	Omnibus Crime Control Act of 1968

PD	Police Department
RCC	Regional Computing Center
RCIC	Regional Crime Information Center
RSC	Regional Switching Center
SEARCH	System for Electronic Analysis and Retrieval of Criminal Histories
SGI	Search Group, Inc.
SIFTER	System for Identification of Fingerprints by Technical Search of Encoded Records
SJIS	State Judicial Information System
SO	Sheriff Office
SPA	State Planning Agency
STACOM	State Criminal Justice Communications
TCIC	Texas Crime Information Center
TDC	Texas Department of Corrections
THP	Texas Highway Patrol
TJC	Texas Judicial Council
TLETS	Texas Law Enforcement Telecommunications System
TYC	Texas Youth Council
UCR	Uniform Crime Reports

ABSTRACT

Requirements analysis and design for the Texas Criminal Justice Telecommunications Network is provided in Volume III of the Final Report of a State Criminal Justice Telecommunications (STACOM) project sponsored by the Law Enforcement Assistance Administration (LEAA).

The project has developed techniques for identifying user requirements analysis and network designs for criminal justice networks on a state wide basis. Techniques developed for user requirements analysis involve methods for determining data required, data collection, (surveys), and data organization procedures, and methods for forecasting network traffic volumes. Developed network design techniques center around a computerized topology program which enables the user to generate least cost network topologies that satisfy network traffic requirements, response time requirements and other specified functional requirements.

The developed techniques were applied in the state of Texas, and results of these studies are presented.

CONTENTS

Figures

Tables

SECTION 1

SUMMARY

1.1 OBJECTIVES OF STACOM STUDY

The State Criminal Justice Communications (STACOM) user requirements study was performed to support the primary STACOM project objective of providing states with the tools needed for designing and evaluating intrastate communications networks. The STACOM project goals are:

(1) Develop and document techniques for intrastate traffic measurement, analysis of measured data, and prediction of traffic growth

(2) Develop and document techniques for intrastate network design, performance analysis, modeling and simulation

(3) Illustrate applications of network design and analysis techniques on typical existing network configurations and new or improved configurations

(4) Develop and illustrate a methodology for establishing priorities for cost effective expenditures to improve capabilities in deficient areas.

To support these overall project goals, and specifically the first, a user requirements task was undertaken to develop and use tools for predicting future criminal justice communications traffic. These tools include techniques of statistical analysis for extrapolating past trends into future traffic predictions, and survey and interviewing techniques for estimating traffic in data types that do not yet exist. The user requirements study was therefore divided into two phases: a study of past trends in existing data types to project future trends in communications traffic for these data types; and a study of new data types that do not yet exist, but which are anticipated, to estimate their future traffic volume.

Network designers then use these estimates of existing and new data types to suggest future intrastate network designs that minimize cost and still satisfy performance requirements. Knowing estimated traffic volumes over a decade, network designers can suggest the best times to upgrade computers or communications lines to keep the performance within the required limits and assure minimum costs.

1.2 TRAFFIC PROJECTION METHODOLOGY AND RESULTS

1.2.1 Existing Data Types

Existing data types contain information primarily used by law enforcement agencies which have been in use typically for several years. These data bases contain files on:

(1) Stolen articles including automobiles, license plates, and other property

(2) Wanted persons

(3) Drivers license information, including driving record and description of driver

(4) Vehicle registration information.

Law enforcement agencies in most states have had access to centralized state data bases containing these file types since the early 1970s. This allows the establishment of historical communication traffic growth patterns and the use of these patterns to project future growth. In the past users have accessed these data files over low-speed communication lines which are defined as 300 bps lines or slower. Many states are now upgrading to high-speed lines which are defined as 1200 bps or faster.

Two causes of past growth of communication traffic into existing data bases have been identified: growth due to communication system improvements, and baseline growth. Communication system improvements that occurred in the two model states were:

(1) Addition of new data bases

(2) Conversion of low-speed communication lines to high-speed lines and new terminal equipment

(3) Addition of new user agencies

(4) Establishment of regional information systems

(5) The use of mobile digital terminals by large municipal police departments.

Baseline growth is the increase in communications traffic that would occur even if there were no communication system improvements and is generally related to:

(1) Increased utilization of existing services

(2) Population and personnel increases

(3) Training.

The first step in our traffic projection methodology was to establish the historical total system traffic growth pattern and to record all past communication system improvements. The second involved the determination of the component of traffic growth caused by past system improvements. This was done by measuring traffic from impacted user agencies or data bases immediately before and immediately after system improvements were made. These increases were short term in nature and were not projected into the future. Baseline growth was calculated in the third step by using the equation:

$$\text{Baseline Traffic Growth} = \text{Total Traffic Growth} - \text{Communication System Improvement Growth}$$

A key assumption of the forecasting technique was that baseline growth in the future will continue as it has in the past. Thus, the fourth step involved using the baseline growth curve established in step three to project future baseline growth. Finally, it is recognized that over the next decade there will be further communication system improvements. The fifth step, therefore, was to identify future expected communication system improvements, their implementation schedule, and their impact on future traffic. The sixth and final step was to combine future baseline growth and growth due to system improvements to obtain future traffic levels into existing data files.

In Texas, system traffic in 1973 averaged 20,000 messages per day and increased to 100,000 messages per day by 1976. Of this increase 45,000 messages per day was baseline growth and 34,900 messages per day was growth due to communication system improvements. Figure 1-1 shows the Texas existing data type traffic projections. It is projected that by 1985 traffic into existing data files will be approximately 310,000 messages per day.

1.2.2 New Data Types

New data types consist of those information files which are not now in common use but which are being seriously considered for future implementation. They include:

(1) Law enforcement agency use of a computerized criminal history (CCH) and offender based transaction statistics (OBTS) file, where "law enforcement agency" includes police, sheriff, state police, federal agencies, prosecutors, county jails, and local probation offices

(2) Court use of the CCH/OBTS file for both felony and misdemeanor court processing in the large metropolitan areas of each state

(3) Corrections use of the CCH/OBTS file from the corrections department headquarters and from the penal institutions throughout each state

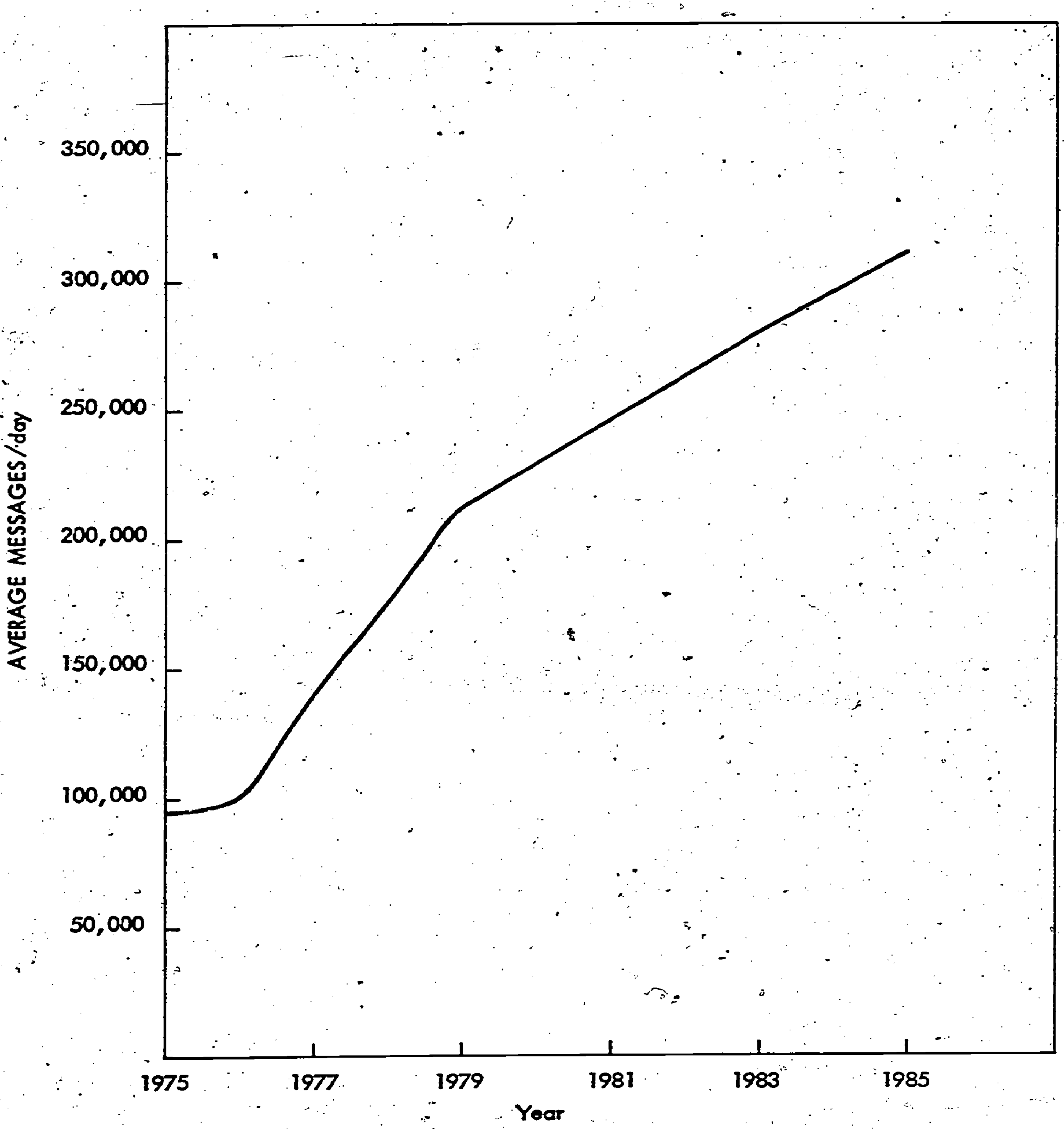


Figure 1-1. Texas Projected Existing Data Type Traffic Growth

(4) Use of the CCH/OBTS files by the agencies in each state that administer parole from state institutions, if it is reasonable for that parole agency to participate in the communications network

(5) A state judicial information system (SJIS) for reporting court statistics from the civil and criminal cases of the courts that handle felonies and misdemeanors in the large metropolitan areas

(6) An offender based state corrections information system (OBSCIS) which is a system of files at the headquarters of each state's correctional agency containing information on all inmates in all the state's penal institutions. Portions of these files might be accessible to terminals in the institutions and in the parole agency.

(7) Juvenile agency records, if it is reasonable for the juvenile detention agency to participate in the communications network

(8) An automated fingerprint encoding, classification, and transmission system for the large metropolitan areas

(9) Traffic from the states' identification and investigation bureaus for converting manual files on offenders into computerized files, and for entering new offender records that are received manually at the state center.

This traffic in new data types is added to projections of traffic from existing data types to obtain total criminal justice system traffic for the next decade. Network design techniques are then applied to this total traffic volume to design a minimum cost criminal justice information system that meets the performance requirements.

New data type traffic forecasts were made using a combination of estimates from operators and users of the present criminal justice communications systems in each of the states, and using extrapolations based on recent history. The new data types were divided into three basic types for purposes of projecting future traffic: (1) Arrest-dependent traffic such as transactions with the CCH/OBTS files which originate at law enforcement agencies, courts, correctional institutions, probation and parole agencies, prosecutors, and federal offices, and including automated fingerprint traffic; (2) Offender-related traffic such as that associated with an OBSCIS system in adult correctional institutions or with juvenile agency traffic; (3) Traffic whose volume is determined by other factors, such as that in an SJIS system which would be determined by court activity, or traffic from a state data center devoted to converting manual records to automated files.

Arrest dependent traffic was estimated by determining the number of offenders through each step of the states' criminal procedures and then projecting the number and types of messages that would be generated at each step of the procedure. Summing these information needs over the procedural steps carried out by a particular agency then yielded the total message volume generated by that agency as a function of the number of arrestees through the process. The approach of assigning information needs to the several steps of a state criminal procedure was first suggested for this project by Bill Griffith of the Ohio Department of Computer Services. This technique was applied to both CCH/OBTS traffic from all criminal justice agencies and to automated fingerprint traffic from law enforcement agencies. CCH/OBTS traffic was allocated to user terminals according to the total FBI index crime in each law enforcement jurisdiction. Court usage was prorated according to the population or court activity in the largest metropolitan areas. Correction usage was distributed according to the number of inmates in the several institutions, and only the headquarters of the parole agency was allocated traffic if that office was a user of the CCH/OBTS files. Automated fingerprint traffic was distributed to the large metropolitan areas according to the population of each city or according to the total FBI index crime in each metropolitan area.

Offender-dependent traffic includes an OBSCIS system for each state's correctional institutions and, if anticipated by the states, a youth agency data system. Traffic was computed by assuming that an inquiry and a file update were generated for every inmate or student in the state institutions every few weeks, and that, if the parole agency had access to an appropriate part of the system, it would also generate inquiries on a regular basis. The estimate of transaction frequency was derived from conversations with correctional institution information system officials who described past experience and provided future estimates of traffic volumes. Traffic was distributed between the institutions according to the number of inmates or students in each facility.

Other types of traffic include an SJIS system, which would produce traffic dependent upon the level of court activity, and data conversion traffic from the state data center, which would depend on the number of employees in such a center and on the volume of records requiring conversion and updating. SJIS traffic was estimated by assuming that only statistical information would be transmitted on state networks and that one message would be generated for each criminal or civil disposition in the courts of the largest metropolitan areas. SJIS traffic was distributed according to the population of metropolitan areas, or according to the volume of dispositions, whichever provided the best statistics. Although an assumption was made throughout the study that criminal activity and communication traffic will increase each year, data conversion traffic was kept constant because it was also assumed that inquiries and file updates will gradually come from remote user terminals rather than from a central state investigative agency.

In Texas, the increase in new data type traffic will be from a 1977 level of about 9,000 messages per day to 90,000 in 1985. The growth in Texas is somewhat low because law enforcement use of the state CCH/OBTS system was reduced to account for the use, by local law enforcement personnel in the major cities, of local or regional data bases instead of the state files. This is already a fact in areas like Dallas, Fort Worth, Houston, and San Antonio, and the tendency will be to continue this practice. Officers in these areas will likely use both state and local files, but state files will not be as heavily used as they would be if they were the only data bases available. New data traffic growth for Texas is shown in Figure 1-2.

1.2.3 Existing and New Data Type Traffic Projections

The existing data type traffic volume of Section 1.2.1 and the new data type traffic volume of Section 1.2.2 were added to obtain the total estimated traffic volume for the study period as shown in Table 1-1 and in Figures 1-3. The derivation of these total traffic volumes is described in Section 5. For the purposes of this summary, it is sufficient to note that, in addition to merely adding the traffic volumes of new and existing data types, the total system traffic was modified to account for a slowing of traffic growth whenever the volume reached a level close to the system's computer capacity, and for a similar brief period of slow growth followed by an accelerated growth period immediately after a computer upgrade. Note that, although existing data type traffic exceeds new data traffic volume throughout the period of this study when measured in units of average messages per day, new data volume far exceeds existing data traffic toward the end of the study period if volume is converted to peak characters per minute. This dominance is caused by the longer message lengths of the expected new data types. Note also that between 1977 and 1985 this study projects about a threefold increase in Texas' traffic measured in average messages per day, and a fivefold increase in demand in terms of peak characters per minute. If existing data traffic continues to increase as it has in the past, and if new data types are implemented at the rate state planners hope they will be, state communication system operators and data system planners should prepare for a continuing program of upgrades to terminals, lines, switchers, and central processors. The necessity of such a program is apparent in Texas, and it is likely that many other states are in a similar growth situation.

1.3 SUMMARY OF NETWORK DESIGN GENERAL METHODOLOGY

Six major activities were carried out in the network design phase of the study. These activities are summarized in the following paragraphs:

1.3.1 Definition of Analysis and Modeling Techniques

A task was undertaken to define and develop specific analysis and modeling tools for general use in intrastate systems. The principal tool developed is the STACOM Network Topology Program. This program, written in FORTRAN V and implemented on a UNIVAC 1108 computer under the EXEC-8 operating system, enables a user to find least cost multidropped statewide networks as a function of traffic level demands and other functional performance requirements.

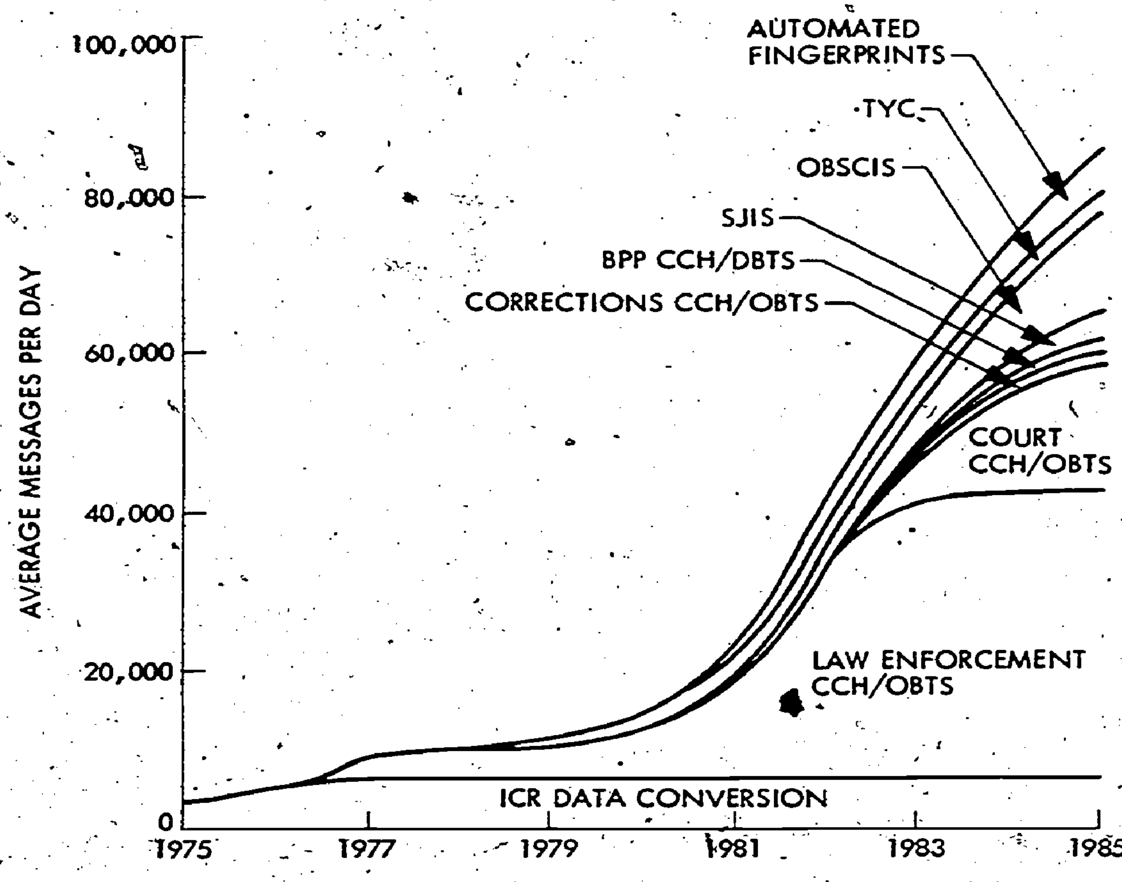


Figure 1-2. Texas New Data Traffic Growth

The major inputs to the program are:

(1) Traffic levels at each system termination on the network

(2) Desired response time at network system terminations

(3) Line tariff structures

(4) Locations of system terminations using Bell System Vertical-Horizontal (V-H), coordinates

(5) The number of desired regional switching center, (RSC), facilities. RSCs serve system terminations in their defined regions and are interconnected to form total networks.

Table 1-1. Total Statewide Criminal Justice Information System Traffic in Ohio

Traffic Summary: Average Messages per Day.

Year	Existing Law Enforcement Traffic	New Data Type Traffic	Total Statewide Traffic
1977	138,490	8,400	146,900
1979	214,190	10,600	224,800
1981	246,600	24,200	270,800
1983	280,200	58,500	338,700
1985	311,000	86,140	397,100

Traffic Summary: Peak Characters Per Minute.

Year	Existing Law Enforcement Traffic	New Data Type Traffic	Total Statewide Traffic
1977	21,160	3,700	24,860
1979	32,720	4,670	37,390
1981	37,670	15,960	53,630
1983	42,810	40,220	83,030
1985	47,510	61,010	108,520

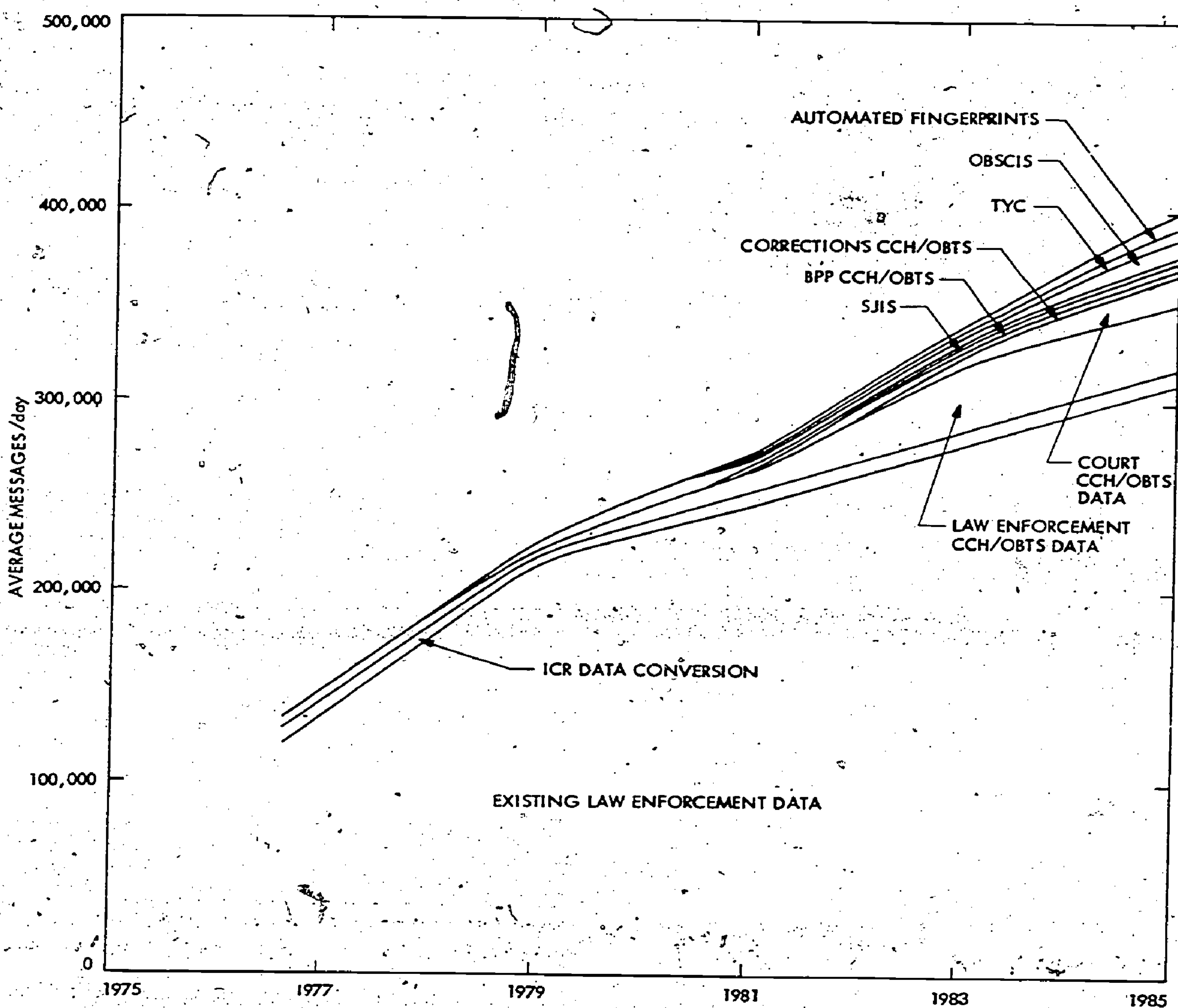


Figure 1-3. Texas Statewide Criminal Justice Information System Traffic Projection in Average Messages per Day

Principal outputs of the topology program are:

(1) Line capacities and layouts servicing system terminations

(2) Fixed and annual recurring costs for lines, modems, service terminals, etc. RSCs are priced separately.

(3) Line performance characteristics such as line utilizations and mean response times

A second major analysis technique enables network designers to determine the reliability and availability of network configurations produced by the topology program.

Finally, a network response time model used in the topology program, is also useful in understanding present and future performance requirements for switching and/or data base computers in the network. This is true because the response time model involves a queueing analysis which includes queueing times encountered at computer facilities.

Descriptions of these design and analysis tools are presented in more detail in Section 7 of this report.

1.3.2 Network Functional Design Requirements

At the completion of state system surveys, and after sufficient interaction with state planning personnel, and prior to any specific network design activity, a document was produced specifying Network Functional Design Requirements. This document provides network performance criteria which are to be met in subsequent designs. The Functional Requirements specify what the network must do, and do not address at this level the specifics of how requirements are to be met.

The network Functional Requirements for Texas are presented in Section 10.

1.3.3 Analysis of Existing Networks

This task employed developed design and analysis tools to determine the extent to which existing statewide networks conform to State Network Functional Requirements. Areas of discrepancy are noted and discussed. Results for Texas are summarized later in this Section. A detailed discussion is presented in Section 11.

1.3.4 Generation of New or Improved Networks

After specific studies of interest were identified with state personnel, STACOM design and analysis techniques were employed to study statewide network configuration alternatives, (options), and additional cost impact studies of interest.

In the State of Texas, three basic network options were considered for the TLETS Network. These involved the study of cost and performance measures for one, two and three region networks as follows:

Option 1 - a single switcher located in Austin (one region).

Option 2 - a switcher located in Austin and second RSC located either in Dallas, or Midland or Lubbock, or Amarillo (two regions).

Option 3 - a switcher located in Austin, and a second RSC located in Dallas with a third RSC located either in Houston, or San Antonio, or Midland, or Lubbock, or Amarillo.

Two additional options were studied involving the possible integration of New Data types in Texas with the TLETS system as follows:

Option 4 - costs for maintaining separate TLETS and New Data networks.

Option 5 - costs for integrating the TLETS and New Data networks into a single network.

Three additional network studies in Texas considered, (1) network cost increases as terminal mean response time requirements were reduced, (2) the impact of network cost and performance due to adding digitized classified fingerprints as a data type to the TLETS system, and (3) the relative difference in network costs between maintaining and abandoning TLETS Network line service oriented toward the existing regional Councils of Government (COGs).

1.3.5 Software Documentation

A final task carried out was the documentation of the STACOM Network Topology Program in the form of a users guide. This document, No. 77-53, Vol. IV, is entitled, "State Criminal Justice Telecommunications (STACOM) Final Report - Volume IV: Network Design Software Users' Guide."

1.4 SUMMARY OF NETWORK DESIGN STUDY RESULTS

The study results itemized below are discussed in more detail in Section 13 in this report. The following summary lists the principal findings of interest for each of the studies carried out.

Texas Study Outcome

- The existing TLETS network does not meet STACOM/TEXAS response time Functional Requirements on low speed lines, and on high speed lines at times of network peak traffic loading.

- The existing TLETS network does not meet STACOM/TEXAS system availability Functional Requirements. The STACOM/TEXAS networks recommended in this study assume the Austin TCIC/LIDR Data Base computer is upgraded to exhibit an availability of 0.9814 and in multiple region cases, switchers are upgraded to provide an availability of 0.997.

- The least cost STACOM/TEXAS TLETS Network is a single region configuration with regional switcher and data base computers located in Austin. Savings for this configuration over continuation of a three region configuration for a period of eight years is estimated at $2,700,000. The line savings realized through the employment of regional switchers (including regional switchers in Dallas and San Antonio, (as in the present system) do not offset the increased costs of regional switcher facilities.

- An eight-year cost savings of approximately $850,000 can be realized through the integration of New Data Type traffic into the TLETS System.

- TLETS network response time requirements for the STACOM/TEXAS single region case can be reduced from 9 to 7 seconds before additional costs are incurred. Reduction to 6 seconds increases annual line costs approximately 3%. Reduction to 5 seconds increases annual line costs approximately 10%.

- Digitized classified fingerprint data can be added to the TLETS network as specified in this report without compromising performance of the STACOM/TEXAS TLETS System.

- There are no meaningful cost savings to be realized by abandoning C.O.G. oriented line service in Texas. Cost is not a factor in a management decision regarding the continuation of this service.

- Existing lines to the TCIC/LIDR Data Base from the Austin switcher should immediately be upgraded to 4800 Baud.

- Existing lines to the MVD Data Base from the Austin switcher should immediately be upgraded to 4800 Baud.

- The mean service time per transaction in the Austin switcher should be immediately reduced to 130 ms. In 1981, the mean service time per transaction should be 100 ms. This will be sufficient through 1985.

- The mean service time per transaction in the Austin TCIC/LIDR Data Base computer should be immediately reduced to 250 ms. From 1981 to 1985 the mean service time per transaction required is 200 ms.

SECTION 2

SYSTEM DESCRIPTION

2.1 GENERAL

Many states already have sophisticated criminal justice communications systems and are continually working to upgrade them. This upgrade process includes modifications to anticipate increased traffic and the addition of new files to make the systems more useful to criminal justice agencies. Texas, one of the two states chosen as an example for this study, is doing exactly this; it already has several data systems for law enforcement and criminal justice agencies with steadily increasing traffic, and it is considering system improvements to user terminals, line speed, and central computers. State planners keep informed and look forward to the day when some of the new data types suggested in this report may be included in the files of the Texas system.

In this report, the central state files of existing data types were assumed to include such items as:

- Wanted persons
- Outstanding warrants
- Stolen vehicles
- Stolen license plates
- Drivers licenses
- Vehicle registrations

New data types that might be added during the period of the study included:

(1) Law enforcement use of state CCH/OBTS files

(2) Court use of CCH/OBTS files

(3) Corrections use of CCH/OBTS files

(4) Parole agency use of CCH/OBTS files

(5) A state judicial information system

(6) An offender-based state corrections information system

(7) A juvenile agency records system

(8) An automated fingerprint encoding, classification and transmission system

(9) State investigation bureau data conversion traffic.

Most of these files were assumed to be located at a central state data center, although it is up to each state to organize the control of its files. In some states, for instance, it might be desirable to keep control of juvenile or corrections agency files within those organizations rather than maintaining them with other state data bases. States will also vary in the distribution of terminals, lines, computers, and switchers. A schematic representation of a state communication system is shown in Figure 2-1, and a diagram of the facilities making up such a system is shown in Figure 2-2. These figures will assist in clarifying the descriptions of the Texas data bases, facilities, users, and functions in the remaining portions of this section.

2.2 SYSTEM DESCRIPTION

For the purposes of this study, the Texas criminal justice telecommunications system includes the present Texas Law Enforcement Telecommunications System (TLETS) with all its data bases and existing terminals and any new terminals that might be added to the TLETS system. In the future it also includes terminals in courts to support the CCH/OBTS and SJIS functions, terminals in the Texas Department of Corrections (TDC) and Texas Youth Council (TYC) institutions and in the Boards of Pardons and Parole (BPP) headquarters for the OBSCIS system, and Texas Department of Public Safety (DPS) Identification and Criminal Records Division (IRC) terminals in Austin for converting manual records to computer input. The system does not include terminals connected to local computers which contain strictly local data bases. For instance, San Antonio and Bexar County have some 200 terminals connected to many data bases that are contained in a computer operated by the San Antonio Police Department. The state telecommunication system terminal in this case is the joint city and county computer, not the individual terminals connected to the computer. These local terminals have access to state files through the San Antonio computer, but, to the state system, it appears that these messages come from a single large terminal in San Antonio.

2.2.1 Data Bases

Most of the data bases in the state criminal justice telecommunication system are located in Austin. The present Texas Crime Information Center (TCIC) contains records on wanted persons, stolen vehicles, stolen guns, stolen boats, stolen articles, and stolen license plates. It also contains a large CCH file, which is treated as a new data type because its usage is low compared to its potential usage, and because in the future it might become the nucleus of an expanded CCH/OBTS system with many more data elements.

Also located in Austin are the files of the Motor Vehicle Division (MVD) which contain records on all licensed drivers and motor vehicles in the state. These files are also accessible to present TLETS users.

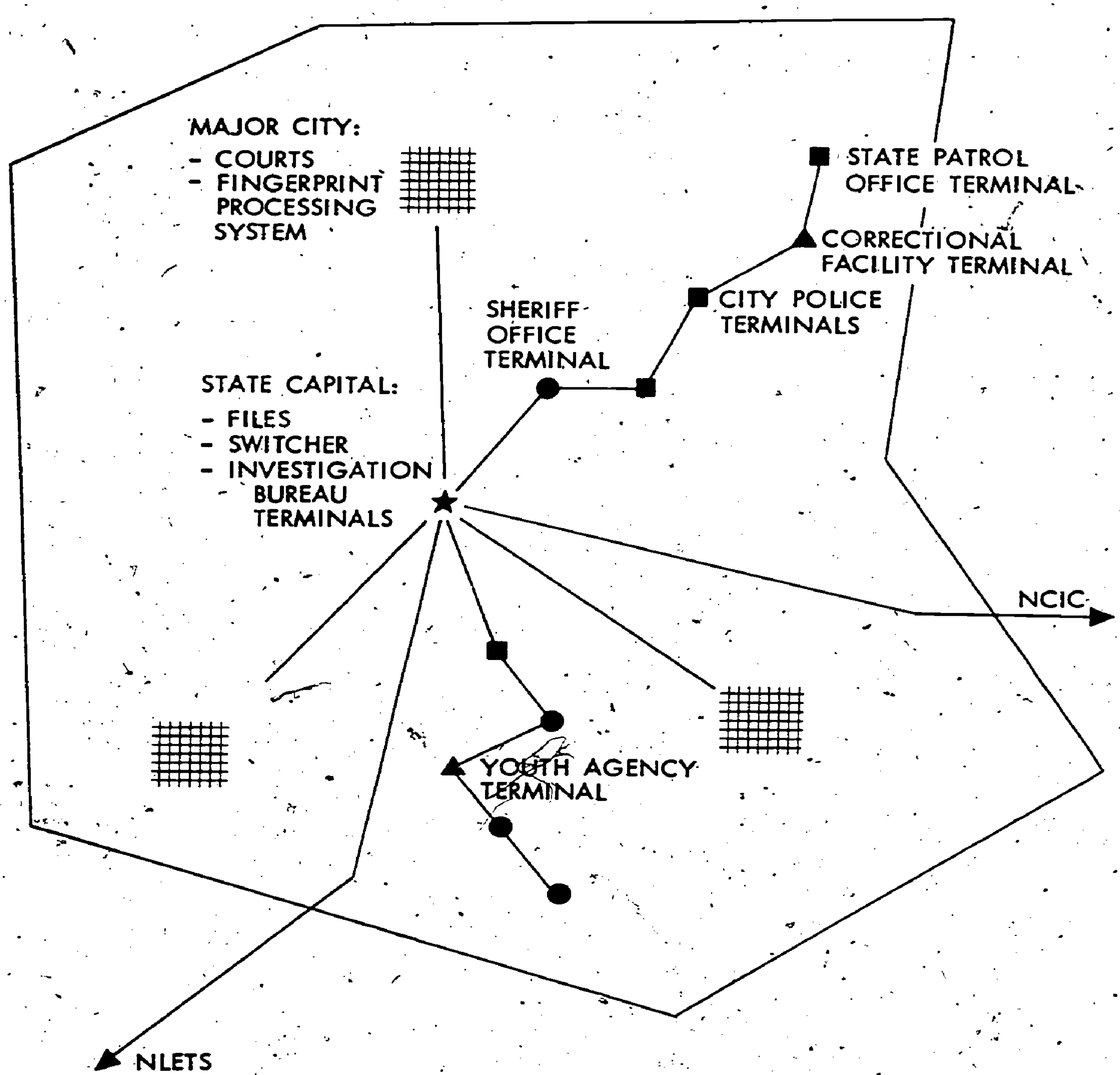


Figure 2-1. State Communication System Schematic

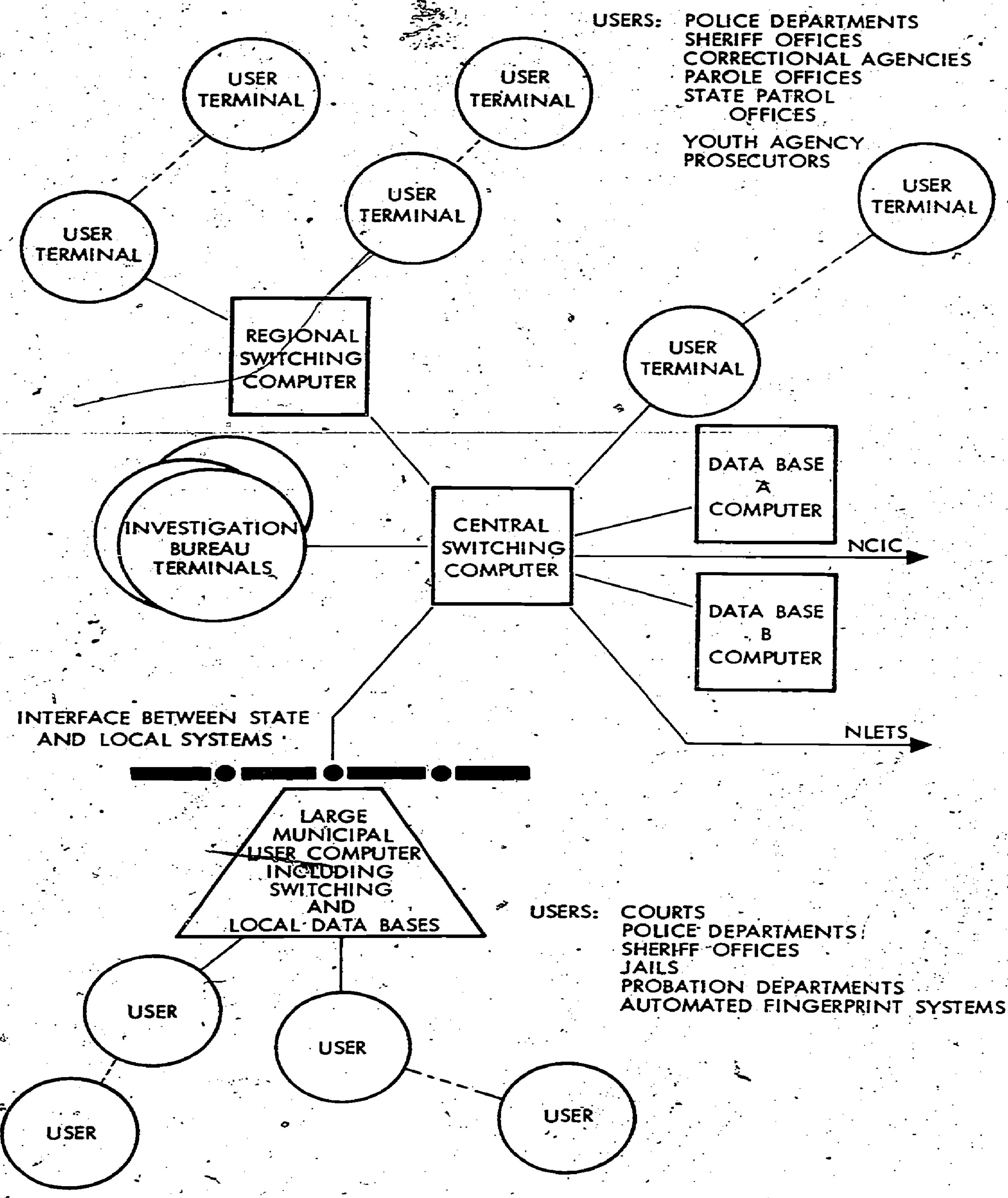


Figure 2-2. State Communication System Facilities

New data types include, in addition to the CCH/OBTS files, data bases required for the systems summarized in Section 2.1. These are:

(1) Statistical data kept by the Texas Judicial Council (TJC) for the SJIS system. This data base would likely be in Austin when and if the system is ever funded.

(2) All of the data bases kept in the TDC computer in Huntsville, some of which - those relating to the inmates' penal records, and not those related to such categories as TDC vehicle maintenance, TDC personnel, or inmate financial records - make up the OBSCIS system.

(3) All of the records on students kept by the TYC. These would probably be kept at TYC headquarters in Austin.

(4) New automated fingerprint files kept by the DPS ICR Division in Austin. These automatic files would be kept in a file separate from, but similar to, the manual fingerprint file presently maintained by the ICR Division.

2.2.2 Users

The users proposed for the Texas criminal justice information system include all of the present users of the TLETS system, any expansion of that system to counties or agencies which would like to participate, and several other criminal justice institutions which have, up to now, not had computerized information systems available to them, or which leased time for batch operation on machines of other state agencies, or which had their own dedicated machines, but were not tied into a statewide system. These additional users are listed in Section 2.1, but are summarized below for completeness:

(1) The law enforcement users of the TLETS system are primarily the local police departments and sheriff offices throughout the state. In addition, DPS offices are tied in, as are several federal law enforcement, military, and investigatory agencies. In the larger cities such as Fort Worth, Dallas, Houston, and San Antonio, the user is a large computer installation provided by the city or county, with individual terminals in the local offices connected to the central local computer. To the statewide networks, the terminal appears as a very large single user, when it is really up to several hundred users on the other side of a single computer.

(2) The proposed statewide system would include the courts in the metropolitan areas surrounding the five largest urban areas in Texas: Dallas-Fort Worth, Houston, San Antonio, El Paso, and Austin. These users would include both District and County Courts, and both criminal and civil court activity. The statewide networks would

allow the courts to inquire into or update the CCH/OBTS files, and it would allow the courts in these areas to automatically send their statistics to the TJC for inclusion in the SJIS system.

(3) The TDC would be connected to the statewide criminal justice information system under this proposal, to allow the 16 TDC institutions to obtain information and update state records in the CCH/OBTS files. In addition, the institutions would be able to communicate with the TDC files in Huntsville to obtain information on inmates.

(4) The Texas BPP headquarters would be able to inquire into state CCH/OBTS files to obtain information on an inmate or parolee, and BPP would also be able to have on-line inquiry capability into the inmate records at the Huntsville TDC headquarters to obtain the latest parole status.

(5) The TYC homes, schools, and headquarters would also be users of a Texas criminal justice information system for purposes of this study. Although there would likely be little traffic between TYC and other agencies, and although TYC would keep its own files at its headquarters in Austin, it is reasonable to include this agency so that any cost savings from economies of scale in the communications network can be passed on to the TYC as well.

(6) Law enforcement agencies in the four largest metropolitan areas would already be users of the statewide system, but new automated fingerprint data would be added to their traffic in future years. This use would consist of both fingerprint cards that had been automatically encoded and classified, and latent prints for search and matching during an investigation.

2.2.3 Facilities

The facilities of a statewide Texas criminal justice information system which would include both existing and new data types would be an expanded version of the present TLETS system. The TLETS system includes MVD and TCIC data bases in Austin, message switchers in Austin, San Antonio, and Garland, lines and modems to communicate with the users, and terminals in the user agencies. Computer installations are located at the MVD and TCIC data bases, at each of the switcher locations, and in the large cities and counties where they serve as the termination of the statewide system and as a central switcher and data-base for hundreds of local terminals, which can access the state system through this local computer.

An expanded statewide system including new data types would have more individual terminals as local agencies came to depend on the speed and utility of the state system. In addition, the SJIS systems run by the courts in the five largest metropolitan areas would each likely require a computer with terminals in the individual courts, since it is anticipated that the SJIS systems would be local record keeping installations, with only statistics sent on to the TJC in Austin. Additional lines and modems would be required for connecting these local SJIS installations into the statewide system.

Similarly, the TDC would require a computer in Huntsville with terminals in the remote institutions to operate an OBSCIS system. This TDC computer has been operating for several years with many data files, and the state system would need to be made compatible if an interconnection were desired. Lines and terminals in the TDC system are slow, and it is likely that they would need to be upgraded to high-speed lines and terminals if the systems were merged.

The TYC presently satisfies its data processing needs by batch runs at night on the Texas Water Development Board computer. If the TYC were to become part of the statewide network, it could either use a central facility in Austin for its files, or, if security and the data volume justified it, the TYC could obtain its own machine and the state network would include both this TYC computer and the terminals in the several homes and schools.

The Texas BPP also runs its present software batch at night on the Water Development Board machine. Because of its unique needs, a similar arrangement would probably be continued even after a statewide criminal justice information system were implemented. However, to obtain more rapid updates on offender status, the BPP would have an on-line terminal able to access both the CCH/OBTS files in Austin and the appropriate TDC files in Huntsville that would be a termination of the state system.

The present switcher locations in Austin, Garland and San Antonio are not necessarily the best to minimize total network cost in the future. It is possible that the network design software which operates on these traffic forecasts will suggest fewer, more, or different switcher locations such as Dallas, Houston, and a city in the West such as Midland, Odessa, or Lubbock. This is even more likely if traffic densities shift to require more terminals in a certain region.

2.2.4 Functions

The statewide Texas criminal justice information system as projected by this report serves a multitude of functions by providing all criminal justice agencies with easily and rapidly accessible data in a wide variety of categories. The present TCIC, License Identification and Driver Registration (LIDR), and MVD files, which are accessible to all TLETS users, contain data on:

- Wanted persons
- Supplemental persons
- Stolen vehicles
- License plates
- Stored vehicles
- Stolen guns
- Stolen boats
- Stolen articles
- CCH file
- Drivers licenses
- Vehicle registration

Texas users can access the national NCIC data base and can communicate with other states over NLETS via the TLETS system. This report suggests that in the coming decade the existing CCH files in TCIC will be expanded to include a complete CCH/OBTS system so that offenders are tracked throughout their criminal career by all criminal justice agencies. For purposes of estimating traffic over such a system, it is assumed that this expanded CCH/OBTS file will be made available to a larger group of users, including more local city and county police agencies, the courts in the five largest cities, the TDC and its institutions throughout the state, and the BPP headquarters in Austin. The functions to be performed by this system are really limited only by the imagination of the individual user agency and the local terminal operators. Data on a wide variety of topics are made available to users in a matter of seconds, and user resourcefulness is the limiting factor in determining the functions to be performed.

Besides the existing MVD and TCIC files, and an expanded CCH/OBTS data base with more users, this report estimates future traffic on the assumption that several more new data types will be added to the system in the next decade, along with the appropriate users. These new data types and users are described in the sections above, and the functions performed by the system are again limited primarily by the imagination of the user and the operating agency.

For instance, it is assumed that the SJIS system, which is not included until well into the 1980s, will be used on a local level for court management, case tracking, and calendar scheduling in both criminal and civil cases. None of this traffic would appear on state lines, however, since state reporting would be confined largely to statistical record keeping.

The existing TDC data system in Huntsville is a very versatile and useful system, functioning far beyond the capabilities of any proposed OBSCIS system, which basically serves an an inmate tracking and record keeping system. In addition to this important offender records function, the present TDC computer contains records on:

TDC budget	Prison store accounts
Personnel records	Industrial goods production

Equipment accounting	Inmate commitment status
Vehicle expense	Inmate mailing list
Local fund accounting	Inmate skills
Food service	Medical inventory
Inmate banking	Research project data
Building construction	Inmate test records
Aircraft utilization	TDC school records
TDC legal defense records	

This study assumes that the TDC would continue to carry out these functions, but that the individual prisons would have faster direct access to state files and to the required TDC files in Huntsville through faster communication lines and terminals. In addition, BPP would have on-line access to the appropriate TDC inmate commitment status files so that it could better plan parole hearings and activities. This would be an improvement over the present BPP batch update from a weekly TDC tape.

The TYC data processing functions are likewise broader than merely keeping track of students at the homes and schools. It is envisioned that, just as in the case of the TDC, the TYC data system will maintain its present functions, and keep its own files, but that the remote homes and schools will have faster on-line access to state files as well as to the appropriate TYC files.

Gradually, as automated fingerprint systems become standardized, less experimental, and less costly, it is expected that Texas will begin to implement such systems, at least in the large metropolitan areas where fingerprint volumes justify the expense of the equipment. The statewide telecommunications system would function to transmit both encoded and classified 10-print cards and encoded latent prints found in an investigation. Fingerprint card information would then be filed, and files could be searched automatically for prints to match latents.

In addition to data base queries, TLETS supports administrative user-to-user messages and "all points bulletin" traffic.

SECTION 3

TRAFFIC GROWTH MODELING - EXISTING DATA TYPES

3.1 APPROACH

Determining future communication traffic levels is of primary importance in assessing the users' needs of a state criminal justice telecommunication system. Future communication traffic levels into existing data files were estimated by examining available past growth trends, and projecting these trends forward. There were two components to past traffic growth: growth due to communication system improvements, and growth due to increased user demand. It was assumed that growth due to increased user demand would continue into the future as it has in the past. Growth due to communication system improvements can be characterized as short term rapid increases and thus it would be inappropriate to project these increases forward. We have instead predicted implementations of future communication system improvements and their impact on traffic levels. Our estimates of these two components of traffic growth are combined to form the prediction of total future communication traffic levels into existing data types.

Once total communication traffic levels are known we must determine the distribution of traffic across all locations in the state. This involves the identification of the paths of general traffic flow as well as a quantification of the number of messages to and from each system user. Models were developed that correlated current traffic levels with user characteristics. These models were then used to determine future traffic distributions.

3.2 DATA GATHERING TECHNIQUES AND RESULTS

In order to perform this analysis, information is needed from Texas concerning current and past network configurations, record types, traffic volumes, message lengths, traffic distributions, operating procedures, user agency characteristics, and planned upgrades. Five years of past data were collected.

Two survey forms were developed to obtain this information. A state level questionnaire was written and given to the communication system planner in the state planning agency. This survey form is shown in Appendix A. In Texas the survey was directed to the proper persons in the state government. We obtained answers to our questionnaire from the Department of Public Safety in Texas.

As seen in Appendix A we began by asking state planners to provide one diagram showing principal components used in information interchange between all criminal justice user agencies. Principal components were defined as:

Data bases

Switchers/concentrators

Terminals

Communication lines

Data bases only included those computers containing records that could be accessed by communication lines considered part of the state information system. We also asked for communication line sizes in bauds which measures the rate that information can be loaded on and taken off communication lines. Finally we asked state planners to identify changes to the above diagram and indicate when these changes were made. Answers to these questions provided a knowledge of current and past network configurations. In general, this information was available.

The second question on the state survey asked for more specific information concerning data bases. We asked for the type and number of records available to system users from 1971 - 1976. A minimum of five years of past traffic statistics were needed to establish past growth trends. Again, Texas provided us with answers to this question.

The third question asked for traffic volume data. We requested monthly communication traffic volumes in units of average messages per day by user agency and message type. The time period was again January 1971 - 1976. Texas had only recently instituted a management information system that provided traffic volumes by user agency and message type. Prior to 1976 Texas recorded only the number of messages per month on each circuit where most circuits served more than one agency Also no message-type distribution was recorded prior to 1976.

The fourth question asked state planners to provide average message lengths by message type. As a check of these numbers, we also asked to see format details for all message types transmitted over the state criminal justice telecommunications system. Texas responded to this question by providing us with a copy of their operating manuals which presented formats required to obtain access to the files. Combining knowledge of message formats with a knowledge of the message type volume distribution allowed us to calculate an average message length.

Question five asked for an origin and destination matrix showing yearly message volume from each user agency to each other user agency in the state. Texas could not provide this information.

The sixth question asked about operating policies that affect traffic volumes. Specifically we asked whether queries into one data file automatically generate queries into other data files and whether there were record update requirements. No answer was obtained to the second question; however, Texas provided information on automatically generated messages.

Finally we asked state planners to inform us of any planned upgrade that would affect traffic against current law enforcement files. We listed examples such as:

(1) An increase in the number of records in a file

(2) A reduction in response time

(3) An increase in the number of user agencies.

Texas provided complete responses to this last question.

The second form designed for the collection of information was the User Agency Questionnaire. (See Appendix B.) This questionnaire was intended to obtain information on user characteristics, on current and desired response time and to obtain from the users an estimate of their current traffic levels. This last item was intended to be a check of similar data requested from the state. User survey forms were sent to all user agencies in Texas. Many, but not all, agencies completed the survey and returned it to us.

As seen in Appendix B user agencies were asked to supply traffic data in the form of the average number of messages sent per day on the state system, the average number of messages received per day on the state system, and the number of messages sent during a peak hour on the state system. Responses were generally consistent with state statistics which were most likely the data source used by the respondents.

Users were next asked for current average response times and acceptable response times. Almost all agencies answered these questions with acceptable response times slightly lower than actual response times.

Finally, user agencies were asked to supply data on the crime rate per capita in their area and the number of personnel requiring information over the state criminal justice telecommunications system. Five years of this information was requested; most agencies supplied it for the current year but did not give historical data.

Because a number of agencies did not respond to the user surveys, other sources of data were identified that could fill information gaps. Uniform crime report data were obtained for Texas. This report presented population and crime statistics for all law enforcement agencies in the state. We also used the national Uniform Crime Reports issued annually by the FBI (<u>Crime in the United States</u>) to obtain information on the number of personnel employed by each agency. Finally the Texas state almanacs were used to verify population statistics.

In addition to survey forms and statistical tables, we conducted personal interviews to collect data necessary for predicting future traffic levels into existing data files. Interviews were conducted with data processing personnel in the larger metropolitan police departments and with persons representing regional information centers. Personal interviews were conducted with these representatives because of the large volume of traffic originating from metropolitan police departments and regional information systems. We asked questions concerning present methods for accessing state data files, future communication plans that would impact communication traffic into the state system, accessibility of information contained in regional data bases to other users of the state system, data types maintained on regional systems, and operating procedures that automatically generate messages from regional data bases into the state data base. We found that on-site interviews were required in some instances; however, we were able to interview a number of these agencies by telephone. Both the large police departments and regional information centers were cooperative and provided the required information.

All the above data were used in our traffic growth and distribution models which will be discussed in following sections.

3.3 ANALYSIS METHODOLOGIES APPLIED TO TRAFFIC STATISTICS

3.3.1 Definitions

Traffic statistics were obtained primarily from the operating agencies of the existing state criminal justice telecommunication systems. The form of the data used to project future growth was monthly message volumes broken out by system users. In examining the data, care had to be taken in interpreting the numbers given and in defining carefully the parameters to be measured.

There are two measures of system traffic that will affect final system design. The first is the number of communication messages transmitted over the system. A communication message is defined as the transmission of information between a sender and a final receiver. For example, when a user is attempting to obtain a record contained in a data base, the sender is considered to be the user and the final receiver is considered to be the data base. Independent of the path of the message, the transmission of the data base query between the user and the data base constitutes one communication message. Once the computer's files have been searched and a response prepared, the transmission of the response from the data base back to the user constitutes a second communication message.

The second measure of traffic affecting system design is the number of transactions handled by the computer. A transaction is defined as the processing by the computer of a request for service. Requests for service include data base searches and preparation of response, data base record modifications, and switching of messages. It is possible for one message into the computer to generate more than one transaction. For example, if a query into the state wants/warrants file automatically generates a message to the national wants/warrants file then two transactions occur: the state wants/warrants data base search and the switching of the inquiry to the national file.

From the definitions above, it is apparent that communication messages demand communication line services while transactions demand computer services. Methods of estimating these parameters from available statistics will be discussed next.

3.3.2 Interpretation of Communication Traffic Statistics

In examining available traffic statistics, the analyst must first determine whether traffic is a measure of communication messages or transactions. If it is established that communication messages are being counted, then a knowledge of computer message handling procedures allows the calculation of computer transactions. Likewise, if it is established that transactions are being measured, then a knowledge of computer message handling procedures will generally allow the calculation of communication message volumes. When it is not clear whether transactions or messages are being counted the analyst must test both hypotheses. Generally by looking for internal consistency or by checking with other independent traffic statistics, it is possible to determine if transactions or messages are being measured.

It is common for statistics gathering routines to record the number of communication messages sent and received from every component of the communication system. Thus a message sent from a user terminal to a data base is recorded as being sent from the user terminal and received by the data base. When total system messages are calculated by summations of messages over all components, this leads to a double counting of messages. Dividing by a factor of two leads to the true message count.

Determination of the number of messages sent from the state system to national communication systems must be handled with care. There are currently two national communication systems, the National Crime Information Center (NCIC) and the National Law Enforcement Telecommunication System (NLETS). The NCIC services data base queries and updates but has no message switching capability. The data base is located in Washington, D.C. NLETS provides message switching capabilities tying together state data bases, but it maintains no data base of its own.

Messages sent from state telecommunication users to the NCIC data base can be generated in two ways. The first involves a direct message between the user and NCIC where the state user utilizes required NCIC formats. The second, and by far the most common, results from a user sending a message into the state computer which then automatically forwards it to the NCIC stolen article file.

Messages into the NCIC data base must travel from the user to the state switching center and from the state switching center to the NCIC data base. Responses then retrace this path back to the user. Communication messages to and from the NCIC should be counted in the following way (see Figure 3-1):

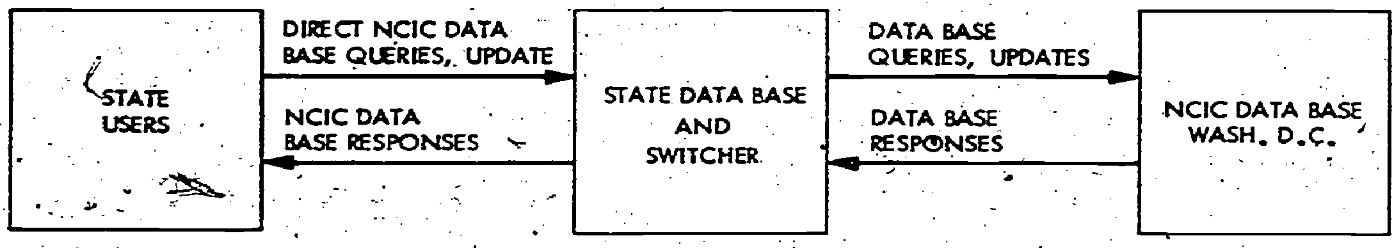


Figure 3-1. NCIC Traffic Flow.

(1) The initial transmission from the user to the state switching center should be counted as a separate NCIC communication message only if it is a direct message between the user and NCIC.

(2) All transmissions of the data base queries and updates between the state switching center and NCIC should be counted as communication messages.

(3) All transmissions of responses to data base queries and updates between NCIC and the state switching center should be counted as communication messages.

(4) The final transmission of the response to the NCIC data base query or update from the state switching center to the user should be counted as a communication message.

Transactions should be counted as follows:

(1) The switching or automatic generation of a message by the state data base computer into NCIC should be counted as a transaction.

(2) The switching of the NCIC response by the state data base computer to the appropriate user terminal should be counted as a transaction.

If the states' traffic statistics do not follow these conventions, adjustments should be made.

Communication traffic traveling from the state system to the NLETS system is measured in the same way as NCIC traffic with the following exceptions. First, all communication messages sent from state system users to other states via NLETS must be sent directly, i.e., there is no automatic generation of messages to other states. Second, other states can originate data base queries into the state data base.

Communication messages to and from NLETS should be counted as follows (see Figure 3-2):

(1) All initial NLETS queries from state users to the state data base should be counted.

(2) All queries from the state data base to other states via NLETS should be counted.

(3) All responses from other states to the state data base via NLETS should be counted.

(4) All transmissions of the NLETS response from the state data base should be counted.

(5) All NLETS queries from other states to the state data base should be counted.

(6) All NLETS responses from the state data base to other states should be counted.

Rules for counting NLETS transactions are:

(1) The switching of an NLETS query by the state data base to other states should be counted.

(2) The switching of NLETS responses by the state data base to state users should be counted.

(3) The file search and response preparation done by the state data base in responding to an NLETS inquiry from another state should be counted.

Again, care must be taken in examining states' procedures for measuring NLETS traffic levels. If the measuring procedures do not follow the above rules, adjustments must be made.

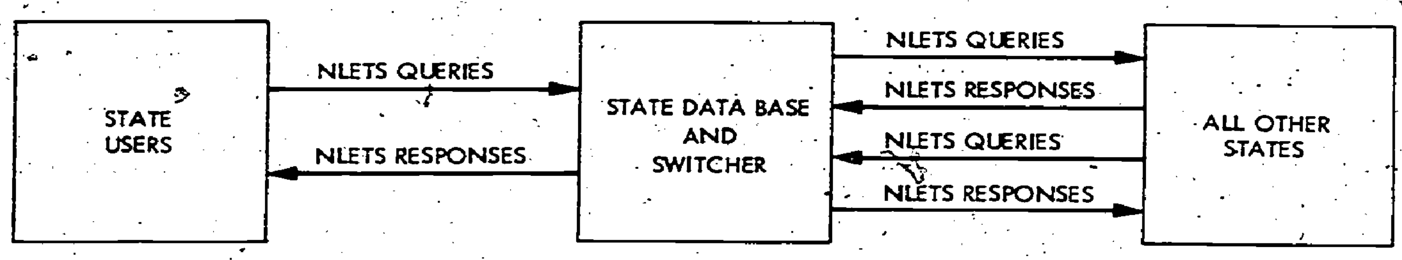


Figure 3-2. NLETS Traffic Flow

Once the traffic statistics have been analyzed and a good measure of the number of communication messages has been obtained, it is necessary to convert traffic from units of messages per day to characters per day. Our procedure for this conversion is presented in the next section.

3.3.3 Message Length

For the purpose of designing a network of communication lines, communication planners must know in addition to the number of messages, the length of the messages so they can determine the number of characters that are to be flowing on communication lines.

Determination of average message length begins by identifying message types and message functions. Message types are the state data base file types, administrative messages, NCIC messages, NLETS data base messages and NLETS administrative messages. Message functions apply only to data base message types and can be grouped into two categories: data base queries and data base modifications.

Lengths of data base message types by message function were determined by examining specified formats in users operating manuals. Response formats were also shown in these manuals. However, there are two possible responses to the query message function. The first is a short response indicating that no record matching the input identifiers could be found. The second, a positive response, is a longer message transmitting the entire record requested. Therefore, it is necessary to know the positive response rate in order to calculate average message length of responses to inquiries.

Average administrative message lengths were estimated by examining example administrative message formats, by discussions with state personnel and by examining available statistics kept by NLETS on administrative message lengths. Since the format of an administrative message is left to the discretion of the user, message length could not be determined by studying format specifications. However, good agreement was obtained from the three sources listed above, increasing confidence in the administrative message length estimates.

Message lengths for NCIC and NLETS messages were obtained from a previous JPL report (National Criminal Justice Telecommunications). These numbers were slightly modified to reflect changes since the JPL report was released.

A simple example of the method for calculating overall average message length will be presented and then the methodology will be generalized to cover our more complex case.

Suppose there are only two message types and the average length of message type 1 is L_1 and the average length of message type 2 is L_2. Also suppose F_1 is the fraction of total messages that are type 1 and F_2 is the fraction of total messages that are type 2. Overall average message length can be calculated as follows:

$$\text{Overall Average Message Length} = F_1 \times L_1 + F_2 \times L_2$$

To continue the example by assigning values let:

L_1 = 100 characters/message

L_2 = 150 characters/message

F_1 = 0.30

F_2 = 0.70

Then:

$$\begin{matrix}\text{Overall Average} \\ \text{Message Length}\end{matrix} = 0.3 \times 100 + 0.7 \times 150 = 135 \text{ char/msg}$$

In our case we have more than two message types and there are also different message functions within message types. We do however know the average message length and the fraction of total traffic of each message function within each message type. We can thus apply the methodology presented above by taking the summation of the products of average message lengths and fraction of total traffic over all message functions and message types. An example is shown below where there are m message types and n message functions within each message type. The fraction of total messages and the average message length is shown for each message function and the calculation of overall average message length is shown at the bottom.

	Fraction of Total Messages	Average Message Length
Message Type 1		
Msg Func 1	F_{11}	L_{11}
Msg Func 2	F_{12}	L_{12}
.	.	.
.	.	.
.	.	.
Msg Func n	F_{1n}	L_{1n}
Message Type 2		
Msg Func 1	F_{21}	L_{21}
Msg Func 2	F_{22}	L_{22}
.	.	.
.	.	.
.	.	.
Msg Func n	F_{2n}	L_{2n}
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
Message Type m		
Msg Func 1	F_{m1}	L_{m1}
Msg Func 2	F_{m2}	L_{m2}
.	.	.
.	.	.
.	.	.
Msg Func n	$\frac{F_{mn}}{1}$	L_{mn}

$$\text{Overall Average Message Length} = \sum_{\left(\substack{\text{Msg}\\ \text{Type}\\ i}\right)=1}^{m} \; \sum_{\left(\substack{\text{Msg}\\ \text{Func}\\ j}\right)=1}^{n} (F_{ij} \times L_{ij})$$

Overall average message lengths in the model states were calculated using the above methodology.

3.3.4 Peak/Average Ratios

In determining needed communication capacity to satisfy performance requirements, we would like to use a measure of demand that reflects the load on the system during the busiest hours. Proper network design requires that service objectives be met during the busiest times as well as the average situation. All previous traffic statistics have given message volumes averaged over a day. To derive the desired traffic measurement we establish the ratio of traffic volume during the busiest hour and average traffic volume and designate it the peak to average ratio. Average traffic volumes are then multiplied by this ratio to give peak traffic volumes.

Peak to average ratios can be associated with different components of the communication system. At the first level we examine peak/average ratio of the number of messages sent from a user agency. The second level involves demand for communication circuits. In some instances, where there is only one user agency on a circuit, this corresponds to the first level. However, for those circuits serving more than one user agency, a separate peak/average ratio can be computed. This circuit ratio is dependent on communication line configuration and therefore changes as new configurations are proposed. To avert this complication we have assumed one constant peak-to-average ratio for the entire communication system. This one value is taken to be the peak-to-average ratio of traffic to the computer. We justify using this as the peak/average ratio for user agencies and communication circuits for the following reasons:

(1) Historically, the utilization level of the computer has been significantly higher than the utilization levels of communication circuits. Therefore it is more important to establish demands for computer service than for communication lines and user agency terminals.

(2) It is likely that the peak/average ratio for communication circuits and for the computer are not greatly different.

(3) There is a possibility that particular user agencies will have peak/average ratios somewhat higher than the computer's ratio. However, it is unlikely that this higher than predicted number of messages would have any impact on network system design since communication circuit utilization is low.

To determine this ratio we examine in detail one month of total system traffic data. The number of transactions occurring each hour in the month is determined. We search for the busiest hour and determine the ratio of transaction volume during this busiest hour to the average hourly transaction volume during the month. This ratio becomes the peak/average traffic ratio.

Predictions of average traffic levels are then multiplied by the peak-to-average ratio to describe traffic levels during the busiest hour.

3.3.5 Output of Analysis of Traffic Statistics

The outputs of the traffic analysis task are:

(1) Historical traffic statistics: 1971 - 1976

(a) Number of average total monthly communication messages

(b) Number of average total monthly transactions

(c) Number of average monthly communication messages by system user

(d) Number of average monthly communication messages by message type.

(2) Current traffic statistics

(a) Average message length by message type

(b) Total average message length

(c) Peak/average ratio.

This information on past and current traffic statistics serves as input into the traffic growth and distribution modeling tasks to be discussed in the next two sections.

3.4 TRAFFIC GROWTH MODELING

3.4.1 Introduction

Before we present our forecasting techniques a note of caution is in order; forecasting is a hazardous occupation. As Martino has said (Technological Forecasting for Decision Making) "The forecaster is never absolutely certain that he has prepared the most useful possible forecast with the data he had available and the resources he employed." Martino continues to describe what forecasting does and does not do. "A forecast does not tell us anything about the future. Instead, it tells only of the implications of available information about the past. These implications are connected with the future through a logical framework. Hence, the utility of a forecast for decision making purposes depends on the validity of the logical framework it uses, and the extent to which it extracts all the implications which are contained in the body of available information." We have attempted to identify the body of available information and develop a logical framework allowing us to use the information to predict future growth of criminal justice telecommunications traffic.

Our basic forecasting framework postulates that past traffic growth is caused by two factors. The first is an increased demand by the users and the second is communication system improvements. We assume that growth in traffic due to the first factor will continue in the future as it has in the past. However, growth in traffic due to communication system improvements will depend on the rate of future system improvements. Our estimates of these two components of traffic growth are combined to form the prediction of total future communication traffic levels into existing data types.

3.4.2 Input Data

Data describing past operations of the state criminal justice telecommunications system included past traffic statistics, past network configurations and past operational procedures. Recall that traffic statistics obtained from states were used to determine the total number of communication messages each month and total transactions each month during the years 1971 - 1976. In addition, these aggregate monthly traffic figures were broken out by message type and wherever possible by user agency.

Data on past network configurations included location, content, and size of data files; communication line configurations and capacities; and lists of all user agencies and their means of access to the state telecommunication system. An operational procedure affecting traffic was the policy regarding the automatic generation of messages from the state computer to the National Crime Information Center maintained in Washington, D.C.

3.4.3 Data Analysis

Historic traffic statistics were used to establish the past growth pattern of communications traffic. Growth in traffic in Texas, shown in Figure 3-3, was characterized by periods of fairly stable growth rates, however, there were erratic periods where large increases in traffic occurred. The sudden increases in traffic were caused by improvements to the communication system. The following improvements were identified:

(1) Addition of new users

(2) Addition of new data files

(3) The substitution of high-speed communication lines for low-speed lines and new terminal equipment.

(4) The formation of regional information systems

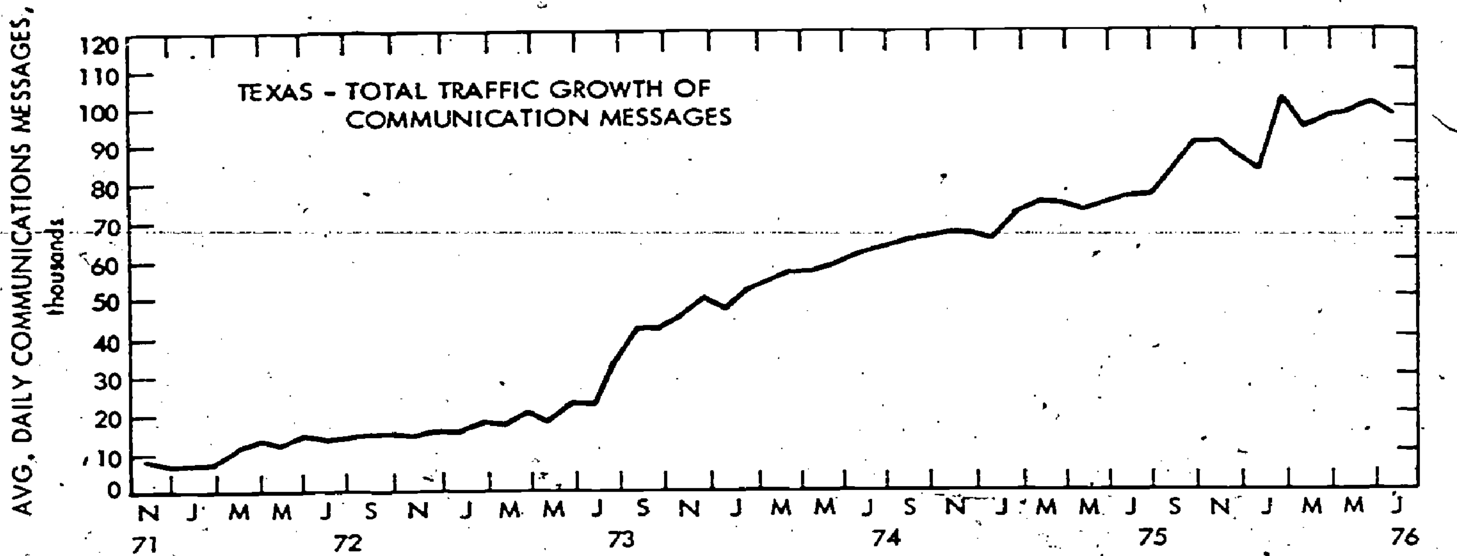


Figure 3-3. Texas Past Communication Traffic Growth

Since these increases in traffic could be tied to specific communication system improvements and were short term in nature, it would be inappropriate to project such increases into the future. It thus becomes necessary to factor out the impacts on traffic of these improvements to the communication system. The remaining growth component is categorized as baseline growth and we see it as being principally caused by:

(1) Increased utilization of existing services

(2) Population and personnel increases

(3) Training.

Baseline growth, shown in Figure 3-4 for Texas, is assumed to continue in the future as it has in the past.

3.4.3.1 Past System Improvements. To obtain baseline growth statistics, we had to establish a procedure for quantifying the impacts on traffic of communication system improvements. Our procedure assumed that the traffic impacts of system improvements were independent of one another. We recognized that in the real world this is not the case, but were confident that the errors caused by non-independence would be small. As an example assume that two system improvements occurred simultaneously and were the conversion of low-speed lines to high-speed lines and the addition of a new data base. To determine the increase in traffic from a particular user caused by the high-speed line upgrade we look at the user's traffic just before and just after the increase. The increase is taken to be caused by the line upgrade. However, a portion of the increase is due to traffic into the new data file. However, during all periods the portion caused by the secondary effect was sufficiently small that it could be ignored. So errors resulting from our assumption of independence are small. Procedures for determining the impacts of each system improvement are now discussed.

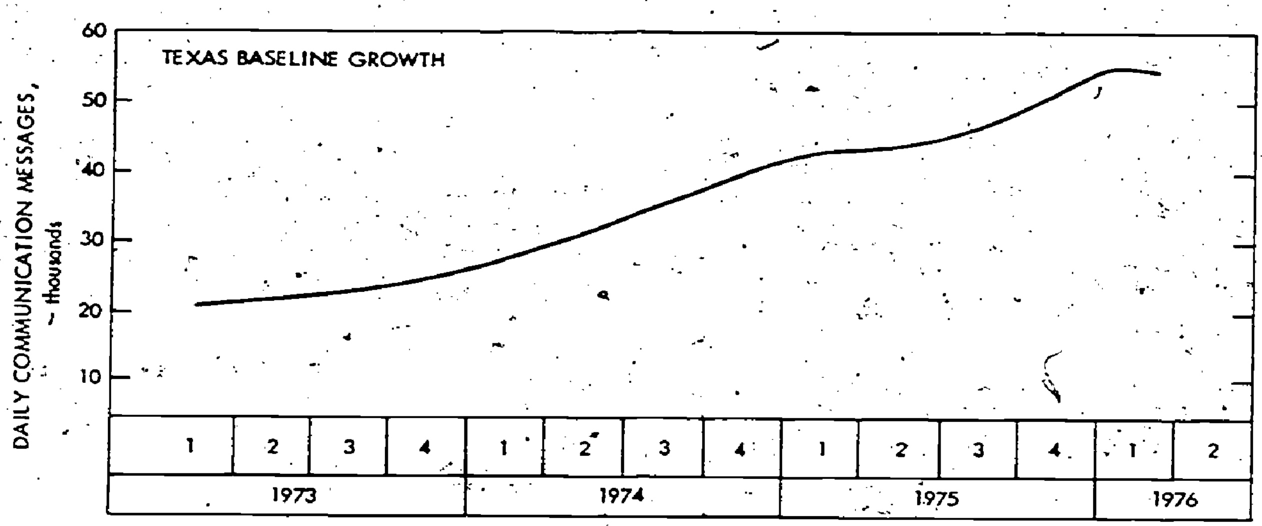


Figure 3-4. Texas Baseline Traffic Growth

Texas has added new user agencies to its communication system over the last few years. We collected a list of all new agencies added within each three month period from 1971 - present. The increase in traffic caused by the addition of a new terminal was obtained by measuring traffic levels from the terminal in the three-month period after it had been added. The average of traffic over this three-month period was considered to be the traffic increase. Where these detailed traffic data were not available for each month, we took the first month these statistics were available, and for all terminals added between the last set of available statistics and this set, the increase in traffic was assumed to be the message volumes reported by the statistics. In Texas, traffic statistics broken out by user were available only for February 1974, February 1975 and all months after May 1976. In Texas looking at the period January 1973 - June 1976, approximately 11,000 of the new messages could be attributed to the addition of new users.

When a new data file is added, there is generally a period of two or three months of rapid growth of traffic into the files followed by a stabilization in traffic volume. It is this sudden increase in traffic that we consider the impact of the implementation of a new data base. An example of traffic volumes into a new data file is shown in Figure 3-5. Traffic increases occur rapidly during the first months of operation of the TCIC data files and then begin to display a somewhat normal growth pattern. The increases due to addition of data bases in Texas accounted for approximately 18,000 new messages per day.

Texas originally designed its state criminal justice telecommunication system with low-speed teletype lines. The state has upgraded a portion of these lines to high-speed 1200 or 2400 baud lines. We define low-speed lines to be 300 baud or slower. Terminals serving low-speed lines are either older teletype terminals or hard copy printing terminals. High-speed lines are 1200 baud or faster and are served by CRT terminals. Texas does not use lines of between 150 and 1200 baud.

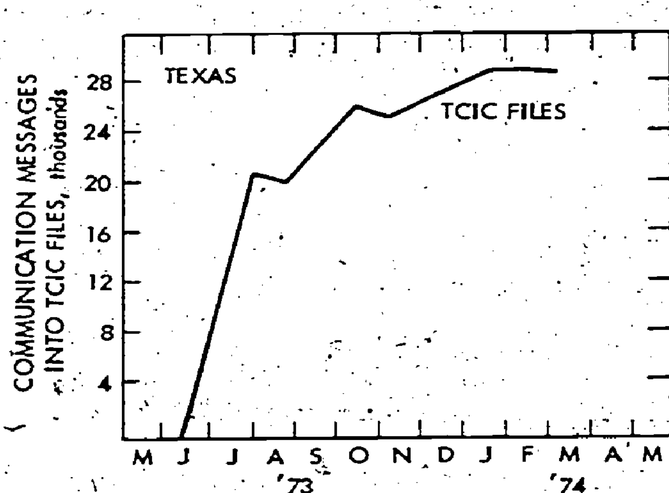


Figure 3-5. Example of New File Traffic Growth

The impact of past conversions to high-speed lines is measured by taking the difference in traffic the month before the upgrade and the month after the upgrade for each affected agency. These increases range from 12% to 200%. In Texas the average terminal doubled its traffic after conversion to high-speed lines.

A number of larger cities have recently implemented or are now in the process of planning for the implementation of municipal or regional information systems. These systems generally consist of a local computer which contains data files of regional interest and also switches messages into the state system. We have noticed an increase in traffic into the state system when these systems are implemented. Possible reasons for this increase are:

(1) Agencies have more terminals with which to access state files

(2) Agencies with no previous access to the state system now have access to a regional system that allows them access to state data files

(3) Computer-to-computer communication is now available between regions and the states.

The impact on traffic of regional information centers was again measured by examining the differences in traffic before and after implementation.

The effects of all the above system improvements in Texas are summarized in Figure 3-6. In Texas slightly more than half the growth could be attributed to baseline growth. In Texas the addition of new data bases, the addition of new users and the conversion of high-speed lines all had major impacts on traffic.

3.4.3.2 Past Baseline Growth. Calculation of baseline growth began by using as input the total monthly historic communication message levels. These statistics were then averaged over three-month periods giving average message volumes for the four quarters of each calendar year. We then determined the component of each of these quarterly message volumes that could be attributed to the communication system improvements discussed above. Traffic caused by system improvements was subtracted from total traffic. The remaining traffic for each quarter was then plotted (see Figure 3-4) and served as a measure of baseline growth.

3.4.4 Traffic Projections

The previous section dealt with establishing past growth patterns and our attempt to relate portions of the past growth to communication system improvements. We will now use the knowledge gained about the past to predict future traffic levels.

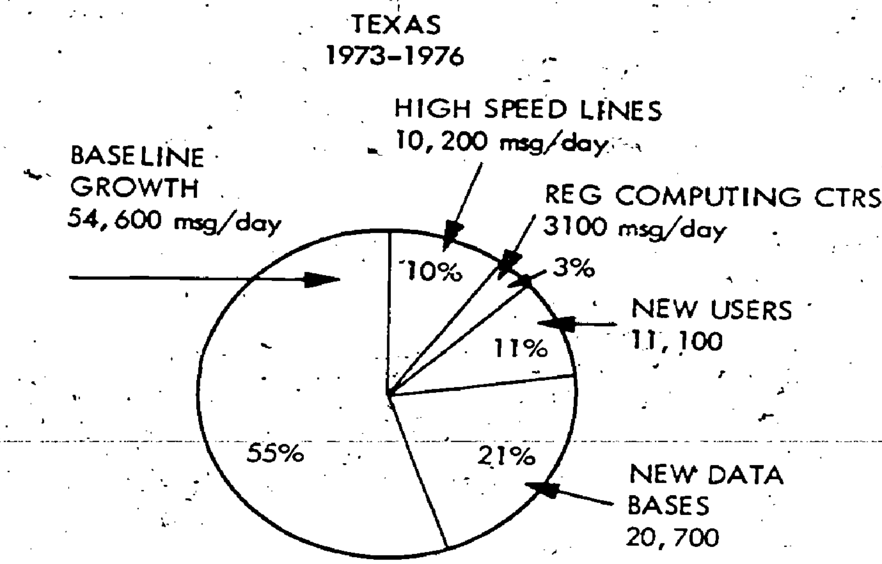


Figure 3-6. Distribution of Traffic Growth Sources

3.4.4.1 Future Baseline Growth. Recall our basic assumption that baseline growth will continue into the future as it has in the past. Past baseline growth curves exhibited the following characteristics:

(1) A long-term increase in traffic

(2) Seasonal effects due primarily to procedures or customs

(3) Periods of relatively slow growth.

Using these characteristics we construct the following baseline growth model. The long-term increase in traffic will continue into the future. Seasonal effects may continue into the future but will have no impact on system design because although these effects have been to cause exceptionally low traffic levels during some months, the system must be designed to handle the loads during peak traffic months. We will thus not include seasonal effects in our future traffic model.

We explain periods of slow baseline growth as being caused by one of two factors. First, growth may be slow because the communication system is near saturation. Users experience deterioration in the level of service with the primary effect being an increase in the waiting time for a reply to an inquiry. Second, growth may be slow immediately following an upgrade because of sub-standard system performance while the inevitable problems of a new system are corrected, and reduced agency utilization while users familiarize themselves with new operating procedures.

Texas baseline growth displays a period of slow growth through the second and third quarters of 1975. Consistent with this slow growth trend is the fact that in the third quarter of 1975, a number of system improvements were made. These included upgrading the Austin Switcher and adding a second communication line between the Dallas and Austin Switcher.

Response time deterioration caused by excessive demands for service is shown in Figure 3-7. Notice that response times stay relatively constant as transaction volumes build until a critical point is reached (about the 80% utilization point). Response times then degrade rapidly. The response time profile just described is consistent with the response time of a central processing computer as transaction volume grows.

In Texas the criminal justice telecommunication system is not completely centralized. Data base computers do not provide switching services and there are switchers in three locations distributed throughout the state. These switchers and the lines connecting them to each other and to the data bases handle large volumes of data and thus have high utilization levels. Texas also has two completely separate data base computers. Thus, because of its distributed nature, response time is not easy to characterize in Texas. A single message depends on service from a number of components that might be overloaded and different message types require service from different components. For example, in July 1975 the throughput capacity of the Austin switcher was increased and a

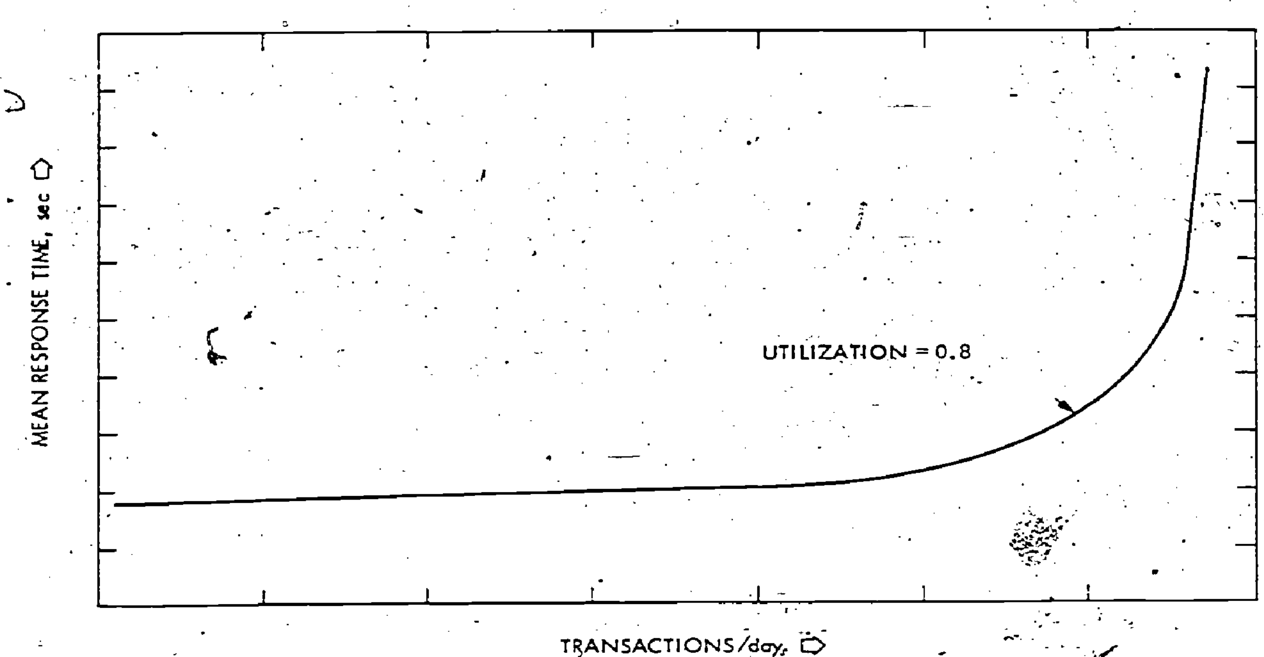


Figure 3-7. Typical Communication System Response Time as Function of Traffic Volume

second high-speed communication line was added between the Austin Switcher and Dallas. This was done to reduce response times to system users served by the Dallas switcher. Any traffic saturation occurring prior to this upgrade was only affecting those terminals served by the Dallas switcher.

We will now use these past traffic baseline growth characteristics to predict future traffic volumes.

We have developed a growth projection model that predicts average daily traffic volume for each of the next 20 six-month periods. The model assumes that growth will be caused by three factors. They are: baseline growth, improved communication technology, and new users and data bases.

We assume baseline growth will continue into the future as it has in the past. In Texas past baseline growth displayed an S-shaped curve with growth being slow before and after system upgrades and linear between these periods. Since baseline traffic growth appears to be dependent on available system capacity it becomes necessary for us to make assumptions regarding actions to be taken by the state when system saturation is reached. Possible actions are:

(1) To increase capacity before saturation is reached to avoid inconvenience to users and allow unconstrained growth

(2) To wait for the first signs of saturation and then increase capacity

(3) To delay for a substantial period any upgrade even after saturation is reached

(4) To fix a limit to growth and not upgrade at all.

In talking with planners in Texas, the second action seemed the most likely. State planners believed that it was not possible to increase capacity before system capacity was reached but did indicate that funding necessary for increasing capacity could be obtained quickly when deterioration in response times was noticed. Thus the shape of the future baseline growth curve was assumed to be basically linear with a slowing of traffic before and after system upgrades.

Our assumption concerning possible actions regarding system upgrades is a critical one. If states decide to delay upgrades for a substantial period or to fix a limit to growth, then our traffic predictions will be substantially high. However, if states decide to increase capacity before saturation is reached, errors in our prediction will not be as large because decreased traffic growth periods have been assumed to be short term.

To project future baseline growth we fit past baseline growth statistics with regression lines and minimize the least square errors. A slow growth line and a fast growth line are developed.

Then, using our knowledge of present system capacity and assumptions on delay before capacity increase and magnitude of capacity increase, we can project these baseline traffic growth lines forward. Figure 3-8 shows our baseline growth projections for Texas.

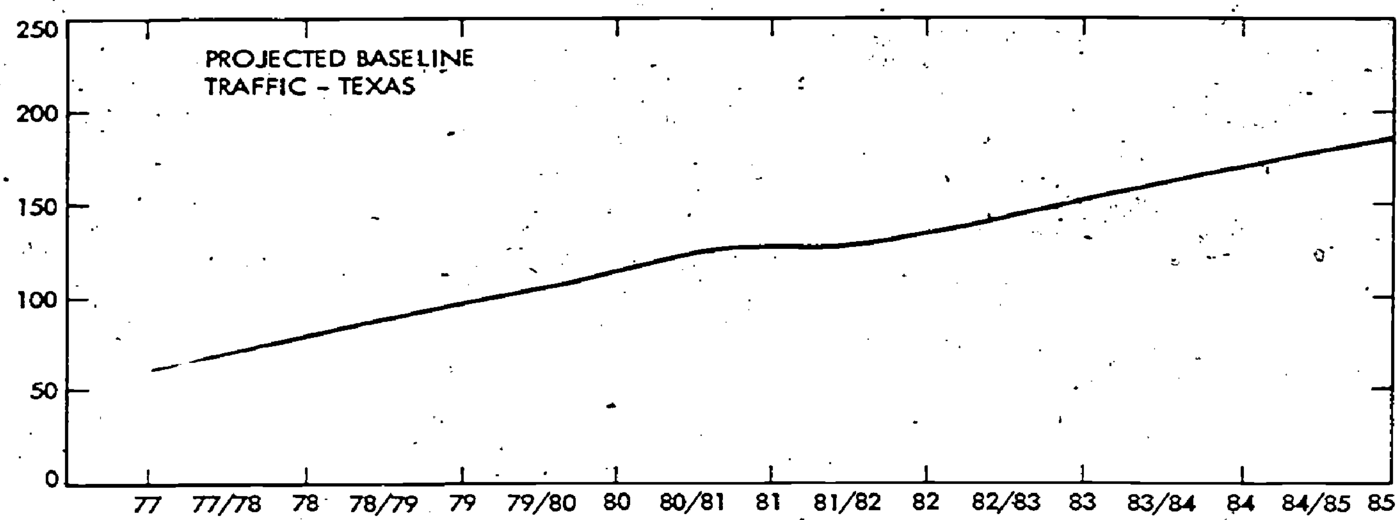


Figure 3-8. Projected Texas Baseline Traffic Growth
(Average Messages/Day, thousands)

3.4.4.2 Future System Improvements. In addition to increases in traffic volumes caused by baseline growth, there will be increases caused by communication system improvements. The future implementations of the following communication system improvements and their impacts on traffic were considered.

(1) Addition of new users

(2) The substitution of high-speed communication lines for low-speed lines and new terminal equipment

(3) The formation of regional information systems

(4) The implementation of Mobile Digital Terminals (MDTs)

(5) Procedural message handling changes.

Information concerning implementation plans was obtained from state planning personnel and there is considerable uncertainty in their future scenarios. However, we did attempt to talk with as many people as possible to gain the most complete understanding of the states' plans.

Texas is currently in the process of replacing all low-speed lines with high-speed lines and is planning to procure new terminals to serve these high-speed lines. Each law enforcement agency will decide whether it wants to join the state telecommunications system. Texas expects all of the approximately 400 agencies served by the system to continue as users and is also planning for an additional 100 to 150 new user agencies. Using a minimum population criteria, we identified 133 potential new user agencies in Texas.

Texas state planners expect these new users to join the communications system in late 1977 and early 1978. Potential traffic levels from these new terminals were calculated by using expressions developed for traffic distribution which will be discussed in detail in the next section. These expressions relate user characteristics such as population served and number of personnel to communication system traffic. We determined that by 1978, some 7,300 messages per day will be coming from or going to these 133 new user agencies.

Texas has plans for converting all remaining low-speed communication lines to high-speed lines. We have estimated the effect of this conversion by assuming that traffic increases in the future will be similar to traffic increases resulting from past line upgrades. Recall that there was a doubling of traffic in Texas when lines were converted from low- to high-speed. Texas plans to complete its conversion by late 1977 and we have estimated an increase of 31,300 msg/day.

Texas provided plans for the future implementation of local automated information systems or improvements to existing regional systems. New municipal systems are being planned for the Waco, Garland, and the El Paso Police Departments. Increases of approximately 1,000 msg/day to and from the state system and each of these departments are expected after implementation. Improvements to the Tarrant County

Judicial Information System and the Houston City Computer system are also expected to increase traffic. Tarrant County plans to allow access to its data files to agencies in adjacent counties. Access will be through the state telecommunication system. Tarrant County expects approximately 1,000 of these msg/day. Houston is planning a major upgrade of its system with the main change being the addition of many terminals. An increase of 6,000 msg/day into the state system is expected when this upgrade is completed.

In conversations with municipal police departments we learned that there is considerable interest in mobile digital terminals. Radio dispatchers currently serve as the link between officers in their patrol cars and the states' law enforcement data bases. Officers must gain the attention of the dispatcher and verbally relay the information necessary for a transaction into the data files. Responses must again be verbally transmitted between dispatcher and officer. Terminals are available that can be installed in patrol cars allowing the officer to enter and receive information directly from data bases. The officer utilizes a keyboard to enter information that is then transmitted digitally from patrol car to dispatcher station and then forwarded automatically into the data base. The response is again automatically forwarded from dispatcher station to patrol car and displayed on a read-out device in the patrol car. Mobile digital terminals thus relieve dispatchers of a portion of their workload; ease communication channel congestion, and facilitate easier access to, and faster responses from, central data bases. It is thus expected that communication message volume will increase when mobile digital terminals are added to police vehicles.

In spite of the advantages mentioned above, the spread of mobile digital terminals has not occurred as rapidly as expected three or four years ago. The primary reason is cost. These in-car terminals cost between $3,000 and $5,000 per unit and municipal police departments find it hard to generate needed funds. In the past, significant funding for mobile digital terminals (there are currently approximately 1,000 operational units throughout the United States) came from the Law Enforcement Assistance Administration (LEAA) which funded these units as a part of an innovative project. It is unlikely that LEAA will continue to provide funds at the previous level for further mobile digital terminals. Thus municipal police departments must evaluate the performance of existing in-car terminals and determine whether mobile digital terminal benefits outweigh their costs.

Clearly the future of MDTs is an uncertain one. To aid us in forecasting future implementation we spoke with state planners, municipal police department planners and mobile digital terminal vendors. These sources agreed that the large municipal police departments would ultimately decide that MDTs were cost effective and equip their patrol cars with them. However, we assumed that only cities with populations of 500,000 or larger would purchase MDTs by 1985.

In Texas we assume implementation of MDTs will begin in 1980 and will be completed by 1984. We predict that 23,000 new msg/day will come as a result of mobile digital terminals.

It is apparent by the size of the increase predicted and the uncertainty in the future of MDTs that this is a possible area of substantial error in our traffic forecast. If in the future it is determined that growth in MDTs is slower or faster than we predicted, adjustments should be made to our traffic forecasts.

There is only one procedural message handling change foreseen in the future that will lead to increased communication traffic being transmitted over state criminal justice telecommunication systems. This involves the elimination of direct lines between municipal police departments and the NCIC data base in Washington, D.C. Currently, in Texas, the majority of messages between the Dallas Police Department and NCIC is transmitted on a direct line between Dallas and Washington, D.C. However, the NCIC is planning in the future to allow access to its data files from only one port in each state. This port will be located at the central site of the state telecommunication system which is Austin, Texas. Therefore, messages that currently are going directly from Dallas to NCIC, and are never counted as being transmitted over the state system, must now first travel over the state system to Austin and from there be sent from Austin to Washington, D.C. We assume this will occur in late 1977. According to statistics maintained by NCIC there are 13,800 msg/day to be added to the state system when the direct Dallas-NCIC line is eliminated.

Table 3-1 summarizes the predicted increases in traffic caused by communication system improvements over the next 20 six-month periods. Designation 77 represents the middle six months of 1977, April-October, while 77/78 represents the last three months of 1977 and the first three months of 1978. The traffic increase numbers are given in units of messages per day and show the expected increase in traffic resulting from each system improvement that occurs in each six-month period.

It is of interest to note that the largest traffic increases will result from the conversion from low-speed to high-speed communication lines and the implementation of mobile digital terminals. In addition, Texas is facing substantial traffic increases due to system improvements over the next few years.

These techniques used for projecting traffic growth forward can be applied in other states besides Texas. The basic steps are:

(1) Analysis of past traffic statistics to determine the historical pattern of total system traffic growth

(2) Determination of past system improvements that would impact traffic growth

(3) Determination of the magnitude and the timing of past increases in traffic caused by system improvements

(4) Determination of the historical baseline growth curve by subtracting traffic increases due to system improvements from total traffic increases

Table 3-1. Future Traffic Increases due to Communication System Improvements (Units are Average Communication Messages per day.)

Time Period	New Users	High-Speed Lines	Regional Information System	Mobile Digital Terminals	Message Handling
77	0	31,300	1,200	0	13,800
77/78	7,300	0	2,200	0	0
78	0	0	2,400	0	0
78/79	0	0	2,400	0	0
79	0	0	1,400	12,800	0
79/80	0	0	200	0	0
80	0	0	600	0	0
80/81	0	0	400	0	0
81	0	0	400	0	0
81/82	0	0	400	0	0
82	0	0	400	0	0
82/83	0	0	0	0	0
83	0	0	0	10,500	0
83/84	0	0	0	0	0
84	0	0	0	0	0
84/85	0	0	0	0	0
85	0	0	0	0	0
	7,300	31,300	11,000	23,300	13,800

(5) Determination of future baseline growth by projecting the baseline growth line or curve forward. Assumptions concerning future system capacity are factored in here.

(6) Determination of future system improvements and their impact on future traffic. Both the magnitude of the traffic increase and the implementation schedule must be predicted.

(7) The last step involves adding together future baseline traffic and traffic due to future system improvements to obtain the forecast for total future traffic into existing data files.

Recall that there is a third growth component which is growth due to the addition of new data types. Section 4 will discuss new data type traffic and in Section 5 we will delineate the method used in combining all three growth components to generate a total future traffic level forecast.

3.5 TRAFFIC DISTRIBUTION MODELING

3.5.1 Approach

Once total communication message volumes are known, we must determine the distribution of traffic among system users. Ideally, we would like to know the amount of traffic sent from every user to every other user. However, this is not possible simply because of the large number of system users. For example, in Texas where there are 431 system users, a matrix with 185,761 entries is required to describe traffic volumes sent from every terminal to every other terminal.

To avert this problem, we begin the traffic distribution task by identifying the major direction of traffic flow on the network. We can then eliminate all the user pairs for which there is very little traffic. Our next step is to determine the number of messages into and out of each user agency. This is accomplished by determining relationships between user agency characteristics and the amount of communications traffic sent and received by the agency. Once these relationships are developed, the final step involves using these relationships to predict future traffic distributions.

5.5.2 Input Data

Data required for the traffic distribution task included, for each current system user:

(1) Number of communication messages sent and received

(2) User characteristics

(a) Population served

72

(b) Number of personnel

(c) Crime rate

(d) Agency type

(e) Type of communication line.

Communication message volumes were obtained from automatically generated statistics describing system performance in Texas. The latest available three months of message volumes were averaged to reduce the effects of abnormalities in one month.

Information concerning user characteristics was generally available. Sources included user surveys, Uniform Crime Reports, the state survey, and state almanacs. We had the most difficulty obtaining data on the number of personnel. The complicating factor was that often an agency with a terminal into the state criminal justice telecommunication system will provide service to adjacent agencies that do not have their own terminals. Thus the user survey asked respondents to report the number of personnel requiring information available over the state criminal justice telecommunications system through the responding agency. Not all user agencies in the model states responded to our survey but for those agencies not responding we were able to obtain data on the number of personnel employed from the Uniform Crime Reports. However, for these non-responding agencies, we were unsuccessful in determining which agencies with terminals were serving agencies without terminals. Thus for those agencies not responding to our survey, there may be errors in the number of personnel statistics.

Additional data were required concerning changes in user characteristics that would affect future traffic distributions. We assumed that population, number of personnel, and crime rate would be distributed in the future as they are now. However, we did account for future changes in communication line types. All low-speed lines were assumed to be converted to high-speed lines by 1979.

Also, the number of agencies served by the telecommunications system was increased if the state expected to add new agencies. User characteristics were collected for the new agencies so that estimates could be made of the future traffic to and from each new agency.

3.5.3 Data Analysis

3.5.3.1 General Traffic Flow. Traffic flows can be determined by examining the functions of the state criminal justice telecommunications system. They are:

(1) To provide access to information contained in state data files

(2) To allow for general distribution messages to be sent to law enforcement agencies in the state

(3) To allow for communication between two law enforcement agencies.

Approximately 90% of all messages in Texas were data base related. Thus the major traffic flow involves messages from users to data bases and the subsequent response. In Texas the major data bases are currently located in Austin, however, access is allowed to a limited number of state users into the Dallas City and Dallas County regional data bases. San Antonio also has plans to allow state users to access its city data base. Thus we must establish traffic flow between each terminal and multiple data bases.

A general distribution message is issued when an agency needs to pass on information to many other agencies. Generally states establish sectors and allow users to send a message to all user agencies in the appropriate sector or sectors. A general distribution message sent to all system users and called an "all points bulletin" message generates a large volume of traffic so operators of the state telecommunication system review the message before it is distributed. In Texas APB messages must also come to Austin for approval. However general distribution messages originating from agencies served by the Garland or San Antonio switcher and only going to other agencies served by the Garland or San Antonio switcher need not travel to Austin for approval.

Administrative messages are free form messages sent between one user agency and another. In Texas the message goes to the nearest switcher which sends it to the appropriate agency.

The only way to completely describe traffic flows on the state networks is to identify the amount of traffic going from every terminal to every other terminal. Recall, however, that this becomes impractical because of the large number of system users. Using our knowledge of traffic functions and major traffic flows, we can reduce the size of the traffic distribution matrix.

In describing traffic flow we must insure that our distribution matrix presents traffic statistics that can be used by the design team to test the major design parameters which are:

(1) The number of switchers

(2) The switcher locations

(3) The communication line sizes

(4) The communication line configuration.

Thus, for example, in Texas we should not attempt to describe traffic between users and the San Antonio switcher because our design team will be examining options where there is no switcher located in San Antonio. The location of data bases is not a design parameter so we can assume data base locations remain unchanged. Also, we will assume that there will be switching capacity located at the state capitol. Keeping these design parameters in mind we now discuss methods for describing data base messages, general distribution messages, and administrative messages.

Since data base location is not a design criterion the number and location of data bases is fixed. We can thus describe the number of messages between each user agency and each data base. Thus, currently in Texas where there are data bases located in Austin, Dallas and San Antonio and 431 user agencies, a 431 x 3 matrix is required.

Messages into the NCIC and NLETS national systems have flow characteristics similar to messages into the central data base. Recall these messages originate from a user agency, flow into the state capitol, are switched to the national system, return from the national system to the state capitol, and finally are switched back to the original user agency. National traffic between users and the state capitol and between the state capitol and the national systems is treated as traffic between users and the central data base. Thus NCIC and NLETS are considered to be system users.

General distribution traffic and administrative traffic are both dependent on the location and the number of switchers. To describe accurately these message flows we need to know the exact communication system configuration. In addition, since these are messages between agencies we would require the complete origin - destination traffic matrix to describe traffic distribution. In order to avoid the need for this information we assume:

(1) General distribution and administrative messages flow as do data base queries to the state capitol

(2) Each user agency sends the equivalent number of administrative messages that it receives

(3) The ratio of general distribution messages sent and received is the same for all user agencies and is equal to the system-wide average.

These assumptions obviate the need to separate administrative and APB message types from data base message types. We need only report the amount of communication traffic between each system user and each data base. Administrative and general distribution messages are included in the count of messages between user agencies and the central data base. These assumptions, of course, lead to errors in the description of traffic flows.

Figure 3-9 shows a user agency that communicates with the state capitol via a regional switcher. An administrative or general distribution message would travel from the user to the regional switcher and then be sent out to the appropriate recipient(s). We assume, however, that the message is sent from the regional switcher to the state capitol and distributed from there. This leads to an overestimation of traffic on the communication line between the regional switcher and the state capitol. An example of the magnitude of this overestimation can be obtained by examining traffic on the existing Texas system. Actual traffic on the line between the Dallas and Austin switchers is 36,000 msg/day; while using the above assumption we would estimate traffic to be 40,000 msg/day, an 11% error. We feel this error is acceptable because:

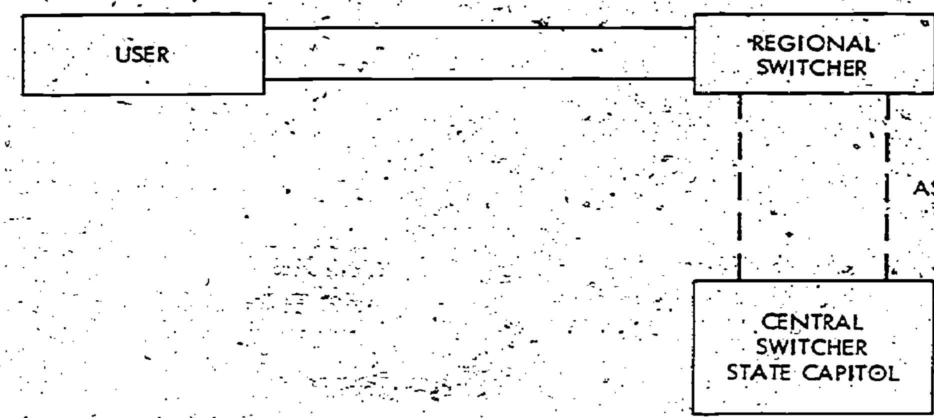


Figure 3-9. Communication System Configuration with Regional Switcher

(1) Overestimates of traffic will occur only on lines between regional switchers and the state capitol.

(2) There is a low probability that overestimates will affect communication system design.

(3) If there are design errors they will be in the direction of excess communication capacity.

We should mention that the above error could be alleviated if in reporting traffic from each agency, administrative and general distribution messages were reported separately. For any proposed system configuration, a closest switcher could be identified for each user agency and traffic could be described as flowing from the user agency to this closest switcher. An unattractive feature of this approach is that the design program would be required to describe traffic between each terminal and a variable number of locations which would be dependent on the number of switchers. It was our opinion that the errors associated with the assumptions were sufficiently small so that the added work required for a more accurate description was unnecessary.

Figure 3-10 shows existing major traffic flows in Texas. NCIC and NLETS have been shown as separate user agencies because of their high traffic volume. The number of data base messages and administrative and general distribution messages between all user agencies and the central data base(s) are shown. Traffic between user agencies and the regional data bases is shown and currently is small in comparison to total traffic.

3.5.3.2 User Characteristics. In order to design the communication line configuration and the line sizes, we must describe traffic in more detail than is shown in Figure 3-10. The amount of traffic between each user agency and data base must be specified. Recall that these statistics are available for the present systems and that we attempt to establish relationships between user agency characteristics and these traffic statistics so that future traffic distributions can be estimated. User characteristics are agency type, communication line type, population served, number of personnel and crime rate.

Agency types are police, sheriff, state patrol and all others. The category "other" includes such agencies as university police departments, bureaus of criminal identification and federal agencies such as the Federal Bureau of Investigation, the Drug Enforcement Agency, the Internal Revenue Service, etc. Distributions of user agencies for Texas are shown in Table 3-2.

Line types currently in use in Texas are 75 bit/sec lines, 110 bit/sec lines, 1200 bit/sec lines and 2400 bit/sec lines. Designating line types of 300 bit/sec or less as low-speed lines and line types of 1200 bit/sec or greater as high-speed lines, Table 3-3 shows the current line type distribution for Texas.

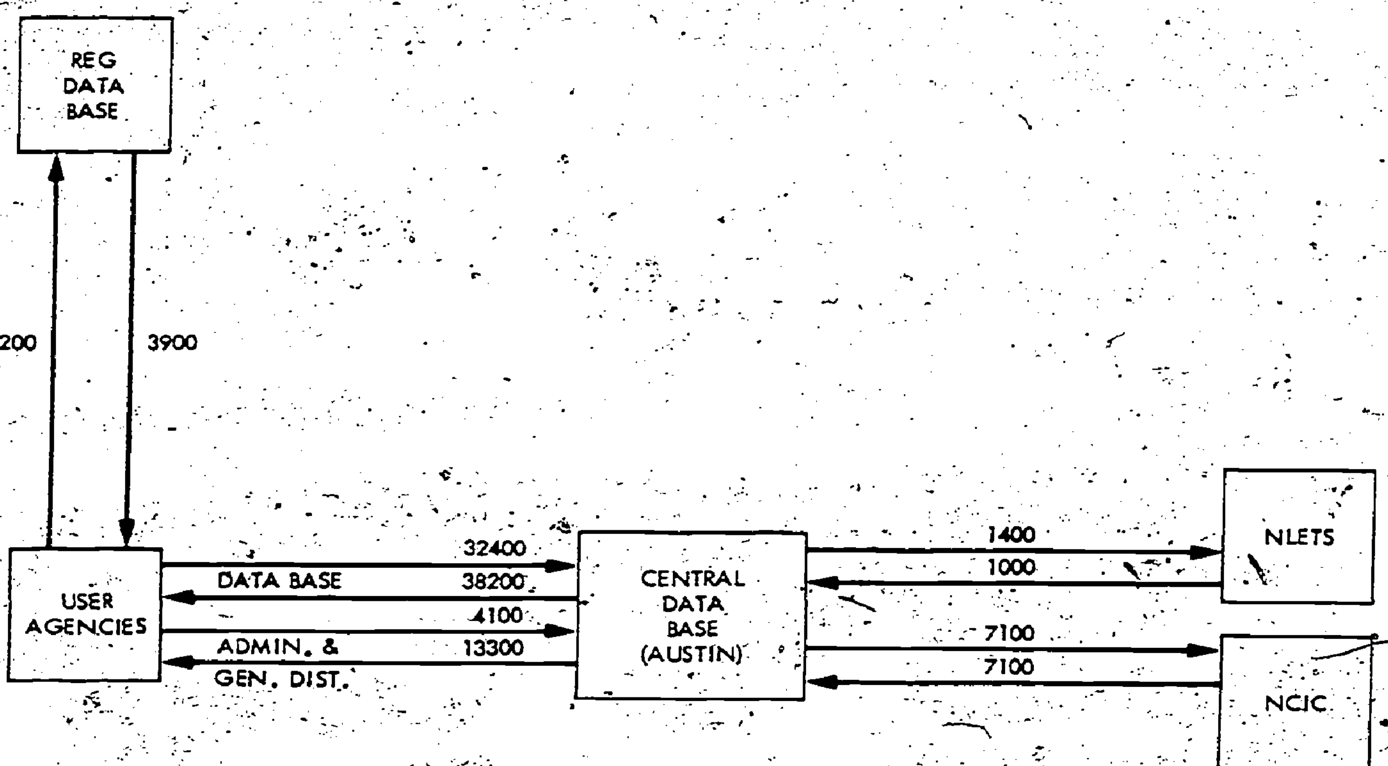


Figure 3-10. Existing Texas Traffic Flow, Average Messages per Day

Table 3-2. Distribution of Texas Users by Agency Type

Agency Type	Number of Users
Police Terminals	229
Sheriff Terminals	135
State Patrol Terminals	46
Other Terminals	21
Total	431

Table 3-3. Distribution of Texas Users by Line Speed

Line Type	Number of Lines
Low-Speed	315
High-Speed	116
Total	431

Texas plans to replace all low-speed lines with high-speed lines.

Table 3-4 shows statistics describing the three remaining agency characteristics.

78

Table 3-4. Texas User Statistics: Population, Number of Personnel, Crime Rate

Agency Characteristic	Number of Agencies Reporting	Average Value	Standard Deviation
Population	347	31,472	107,038
Personnel	295	78	236
Crime Rate	348	3,746	2,919

There is considerable variation in the characteristics of the agencies served by these communication systems, especially in population served and number of personnel as these characteristics have standard deviations considerably larger than their mean. To further investigate variations in user characteristics, frequency tables were constructed showing the number of agencies falling within population and personnel categories. (See Tables 3-5 and 3-6).

Table 3-5. Population Distribution of Texas User Agencies

Population Category	Frequency	% of Total
Less than 5,000	72	21
5,000 - 10,000	83	24
10,000 - 20,000	102	29
20,000 - 30,000	30	9
30,000 - 50,000	24	7
50,000 - 100,000	20	6
100,000 - 200,000	8	2
200,000 - 500,000	5	1
500,000+	3	1
Total	347	100

Table 3-6. Number of Personnel Distribution of Texas User Agencies

Personnel Categories	Frequency	% of Total
Less than 10	41	15
10 - 20	80	27
20 - 30	49	17
30 - 40	29	10
40 - 50	21	7
50 - 100	36	12
100 - 200	22	7
200 - 500	10	3
500+	7	2
Total	295	100

In both states a large percentage of users are small agencies with 75% of all Texas terminals being located in agencies serving 20,000 or fewer people.

User characteristics clearly demonstrate the tremendous diversity existing between agencies served by the state telecommunication system. The methodology used in distributing traffic to these diverse agencies is covered in the next section.

3.5.4 Traffic Distribution

3.5.4.1 Regression Techniques. Regression analysis is a technique that identifies potential functional relationships between independent and dependent variables. In our case we attempt to develop a relationship between the dependent variable of the number of communication messages and independent variables consisting of different forms of the parameters:

Population - POP

Personnel - PERS

Agency Type - AT

Communication Line Type - LT

Crime Rate - CR

we considered the following forms of the above parameters in attempting to explain the number of communication messages between each user and the data bases.

POP	$(POP)^2$	$(POP)^{1/2}$	POP • PERS	PERS • AT	AT • LT	LT • CR
PERS	$(PERS)^2$	$(PERS)^{1/2}$	POP • AT	PERS • LT	AT • CR	
AT	$(AT)^2$	$(AT)^{1/2}$	POP • LT	PERS • CR		
LT	$(LT)^2$	$(LT)^{1/2}$	POP • CR			
CR	$(CR)^2$	$(CR)^{1/2}$				

The variable selection procedure of stepwise regression was applied to these independent variables. Stepwise regression selects from our total set of independent variables, those that are most highly correlated with the number of communication messages. It then utilizes the standard least squares technique to develop a functional relationship between communication message volumes and the chosen independent variables. The usual procedures were followed in determining the best coefficients for the model relations. (See Draper and Smith.)

3.5.4.2 Results. Like user characteristics, communication traffic levels vary greatly between system users. This increases the difficulty of the modeling task because even though we may be able to explain a substantial percentage of the variance, the standard error of our estimate may be high with respect to the mean.

In order to alleviate this problem, we have chosen to divide the user agencies into more homogenous groups in terms of information needs. In Texas the following groups were formed:

(1) Police Departments (PDs) and Sheriff Offices (SOs) serving fewer than 20,000 people

(2) Police Departments and Sheriff Offices serving between 20,000 and 100,000 people

(3) Police Departments and Sheriff Offices serving more than 100,000 people

(4) All offices of the Department of Public Safety

(5) All others

Police departments and sheriff offices were combined because they perform similar law enforcement functions and thus have similar information needs. State patrols on the other hand concentrate their law enforcement activities on traffic enforcement only. Other terminal groupings were tried such as combining terminals by agency and line type and by line type only. However, regression models developed for these groupings had larger standard errors and explained a smaller percentage of the variance than our final classification procedures.

Values used for line type and agency type were:

Line or Agency Type	Independent Variable Values
75 bits/sec	1
110 bits/sec	2
1200 bits/sec	3
2400 bits/sec	4
Police Dept.	1
Sheriff Office	2

Crime rate is a measure of the incidence per 100,000 population of the seven major index crimes (murder and nonnegligent manslaughter, forcible rape, robbery, aggravated assault, burglary, larceny, and auto theft).

Personnel is a measure of the number of employees whose information needs are being served by the computer terminals. Population is the size of populace served by the agency.

Table 3-7 shows the expressions which best describe the relationship between user characteristics and communication message volumes in Texas. These are complex expressions that in many cases contain different forms of the same variable. The following conclusions can be reached.

Personnel number is an important variable in determining the number of communication messages as it appears in all four expressions. As the number of personnel increases, the number of communication messages increases. The rate of increase of communication messages as personnel increases slows down for smaller agencies, and in general, stays constant for other groups.

Population appears in one of the four expressions. Since population and personnel are positively correlated, and since personnel is more highly correlated with communication message volume, population is often excluded from the regression equations. In the expression containing population, the coefficient is sufficiently small such that the magnitude of the term containing population is small compared to the magnitude of the total expression.

Table 3-7. Regression Results - Communication Message Volumes (Messages per Day)

P.D. and S.O. < 20,000 People

$$70.3 + 12.0\ (LT)^2 + 0.549\ (PERS)(LT) - 0.002\left((PERS)^2 - 15.83\ (LT)(AT)\right)$$

P.D. and S.O. 20,000 - 100,000 People

$$563 + 0.028\ (PERS)^2 + 195\ (PERS)^{1/2} - 1.05\ (PERS)(AT) - 15.0\ (PERS) + 0.002\ (POP)(LT)$$

P.D. and S.O. > 100,000 People

$$-671 + 87.6\ (LT)^2 + 0.002\ (PERS)(CR) - 13.3\ (PERS)$$

Department of Public Safety (D.P.S.)

$$-88.46 + 197.6 \cdot LOG\ (PERS)$$

Line type is important in determining communication traffic volume. The only places where it does not appear are t[illegible] groups in which all agencies have the same line types. In all gr[illegible] [illegible]ere a fraction of the agencies have low-speed lines and a fra[illegible] [illegible]ave high-speed lines, the high-speed line agencies display signi[illegible]ntly higher message volumes.

Agency type enters into the expressions of only two groups, small- and medium-sized police departments and sheriff offices in Texas. In these instances, sheriff offices have less traffic than police departments.

Finally, crime rate appears in only one of the expressions and is not highly correlated with communication traffic levels.

These expressions, although different for each state, yield information useful to all states in determining traffic distributions. Conclusions are:

(1) Personnel and line type are important in determining traffic levels.

(2) Crime rate does not affect traffic levels.

(3) Personnel and population to a large extent measure the same thing, i.e., the size of the agency. Since personnel is entered in the above expressions, there is no need for population to play a significant role.

(4) Police departments and sheriff offices should be treated separately from state patrol offices.

(5) Sheriff offices and police departments may or may not have different traffic levels.

The expressions developed cannot be applied per se to any other states. However, the data collection and analysis procedures leading to the development of similar expressions is the same for all states. The steps of the procedure are:

(1) Determine general traffic flow. If a large percentage of messages are data base messages, describe message flow between each system user and data bases.

(2) Compile a user agency data base. Information on number of personnel, size of population served, size of communication line, agency type and any other parameter that may impact traffic volume should be collected for each user agency.

(3) Determine the number of messages sent and received from each terminal over a recent three month period.

(4) Develop relationships between traffic volume and user characteristics. Develop one relationship for each of the following groups.

(a) Police Departments and Sheriff Offices serving less than 20,000 people

(b) Police Departments and Sheriff Offices serving between 20,000 and 100,000 people

(c) Police Departments and Sheriff Offices serving more than 100,000 people

(d) State patrol.

(5) Use these relationships to predict future traffic distributions.

3.5.4.3 Accuracy of Results. The expressions developed in the previous section attempt to describe the number of communication messages originating from each user agency as a function of user agency characteristics. After the expressions are developed, we must assess their accuracy. Table 3-8 presents statistics describing the effectiveness of the regression equations.

Standard error is a measure of the differences in the actual communication traffic levels, and the levels calculated using the regression expressions. If:

y_i = Actual values of the dependent variable

$\hat{y}_i$ = Predicted values of the dependent variable

n = Number of observations

Then the standard error is:

$$\left[\sum_{i=1}^{n} \frac{(y_i - \hat{y}_i)^2}{n}\right]^{1/2}$$

If the standard error (SE) is small, we can be assured that our regression equations yield communication traffic volume close to the actual values. In our case, the standard error values are significant. However, the standard error should always be evaluated in relation to the mean value. If the standard error is small with respect to the mean, then our regression equations help us in assessing the amount of traffic originating from each user agency. The ratio SE/Mean is shown in Table 3-8. These ratios lead to fairly large error terms around predicted values, but the predictions are sufficiently accurate for our network design purposes.

Table 3-8. Accuracy of Regression

Agency Categories	Standard Error	R^2	Mean Traffic	F-Ratio	SE/Mean
P.D. and S.O. < 20,000	48	0.68	106	32	0.45
P.D. and S.O. 20,000 - 100,000	98	0.98	266	384	0.37
P.D. and S.O. > 100,000	658	0.99	2,580	307	0.26
Depart. of Public Safety	120	0.21	312	3.45	0.38

The statistic R^2 is a measure of the amount of variation in the dependent variable explained by the regression equations. An R^2 value of 1.0 would mean a perfect fit between observed and calculated values. The closer R^2 is to 1.0, the larger the proportion of total variation about the mean is explained by the regression equations. In Department of Public Safety agencies in Texas, the regression equations explain very little of the variation.

After the regression is performed, statisticians always consider the possibility that their entire approach was wrong. They ask themselves whether or not any of the independent variables should be included in the regression equation. This is equivalent to testing the hypothesis that all coefficients are zero. The F-ratio allows them to test this hypothesis. The larger the F-ratio, the more confident statisticians are in rejecting this zero coefficients hypothesis. In all cases, our F-ratios are sufficiently high such that we can reject the hypothesis with a high degree of confidence.

3.5.4.4 Future Traffic Distribution. Once these expressions for distributing traffic have been developed, they must be applied to the future traffic projections. The expressions are used to determine, at each future point in time, the percentage of total communication messages from and to each user agency. We have developed distributed traffic projections for years 1977, 1979, 1981, 1983 and 1985. A new user characteristic data base is used for each of these future time periods so that expected changes in line type, population and personnel can be reflected in future traffic levels.

Also, in the future there will be improvements to the communication system for a small number of user agencies that will cause their message volumes to increase. These increases will not be due to any factors contained in the regression expressions but will be caused by:

(1) Establishment of Regional Information Systems

(2) Mobile Digital Terminals. (See Section 3.4.4.2.)

For these few user agencies, the percentage of total traffic will be increased to account for the above system improvements.

The last step in the traffic projection process is the conversion of traffic volume units from average messages per day to peak characters per minute. Messages are converted to characters as follows:

If

T_m = Average Traffic in Units of Messages/Day

L = Average Message Length in Characters

T_c = Average Traffic in Units of Characters/Day

then:

$$T_c = L \times T_m$$

This is then converted to peak characters per minute.

If:

P = Peak-to-Average Ratio (See Section 3.3.4)

T_p = Peak Traffic in Units of Characters/Minute

then:

$$T_p = T_c \times P \times \frac{1 \text{ day}}{1440 \text{ min}}$$

We are thus able to specify the traffic to and from each user terminal in units of peak characters per minute.

SECTION 4

TRAFFIC MODELING AND GROWTH PROJECTIONS: NEW DATA TYPES

4.1 DATA DESCRIPTIONS

New data types whose volumes are projected into the future in this section are summarized below. They are:

(1) Law enforcement use of state CCH/OBTS files

(2) Court use of CCH/OBTS files

(3) Corrections use of CCH/OBTS files

(4) Parole agency use of CCH/OBTS files if the agency is distinct and if the parole officers would not use law enforcement terminals in their areas

(5) A state judicial information system

(6) An offender-based state corrections information system

(7) A juvenile records system if the model state believes that it is feasible to include these data on a statewide criminal justice information system

(8) An automated fingerprint encoding, classification and transmission system

(9) State investigation bureau data conversion traffic.

The growth in traffic from these data types is shown in Figure 1-2. Descriptions of the files, users, hardware, facilities, and functions are provided in Section 2. This section outlines the methodology used to forecast traffic in these data types for the next decade. Other data types were considered, such as boat registrations and state parks department files, but were rejected because it is likely they would be used infrequently compared to those included in the study and would contribute an insignificant amount of traffic to the system. These minor data sources would therefore not alter the state network significantly, nor would they change the network performance.

4.2 SECURITY AND PRIVACY CONSIDERATIONS

To comply with Section 524(b) of the Omnibus Crime Control and Safe Streets Act, the National Criminal Justice Information and Statistics Service (NCJISS) of the Department of Justice's Law Enforcement Assistance Administration (LEAA) has published regulations in the Federal Register (40 FR 49789 of October 24, 1975, as amended by 41 FR 11714 of March 19, 1976) designed to assure the privacy of information on individuals contained in state criminal files and to assure the security of the files and means of access to them. The regulations seek to maintain the integrity of state criminal justice files by focusing on five major concerns:

(1) Assuring the completeness and accuracy of the information kept in the files

(2) Limiting the dissemination of information in criminal files to criminal justice and other lawful purposes

(3) Auditing the state agencies to assure compliance with the LEAA regulations

(4) Protecting the physical security of state criminal files from destruction and unauthorized access

(5) Allowing individuals whose records are contained in state criminal files to review and correct any erroneous information contained in them.

All states are required to submit plans for assuring the proper handling and operation of state criminal files. Texas is in the process of complying with these regulations, and it is expected that all local criminal justice agencies in the state will likewise be required to comply, since the regulations apply to all state and local agencies that have received LEAA funds after July 1, 1973, for criminal records systems.

These LEAA regulations are expected to have very little effect on traffic through a Texas criminal justice telecommunications system, since many of the state's criminal justice agencies already have their own individual security policies, and all users will be asked to comply with user agreements designed to assure compliance with LEAA requirements. For purposes of the traffic projections in this study, it has been assumed that the Texas state plan for assuring the integrity of criminal records will be accepted by LEAA and that agencies responsible for the records, and user agencies, will comply with the approved state plans. It appears that none of the information transfers that have been identified as generating new data type traffic will be inhibited by security and privacy regulations. Traffic is therefore assumed to be unconstrained by security and privacy regulations. It is likely that other states will also comply with the federal guidelines and that their criminal justice communication system traffic will be similarly unconstrained. Such compliance will allow states to obtain maximum utility from the system.

4.3 DATA GATHERING TECHNIQUES AND RESULTS

4.3.1 Traffic Volume

Information on what future traffic levels in new data types might be was gathered primarily from state officials who have been administering criminal justice information systems in Texas for the last several years, and from officials (often the same people) who are planning for the future of these systems. Responses from these data system administrators and planners were gathered in the form of written answers to formal written inquiries, by informal personal conversations, and by formal personal presentations to large groups of state officials who were invited to criticize the assumptions and analyses used in projecting future traffic in new data types.

In addition to talking with administrators and planners at the state level, data on the future of the state criminal justice information system were also obtained from speaking with local users in city police departments, and other local agencies such as county courts and sheriff offices. The following list summarizes the types of agencies visited in Texas:

State criminal justice information system operators

State criminal justice information system planners

Law enforcement users of the state and local criminal justice information systems such as city police departments and county sheriff offices

State judicial system planners and administrators of state judicial system statistics services

Operators and planners of local judicial information systems for general jurisdiction courts

Administrators and planners of state corrections information systems

Operators of state youth agency information systems

Administrators and planners of state parole information systems.

The following list summarizes the types of vehicles used to obtain estimates of future new data traffic volume from these several agencies:

(1) Formal written questionnaires (see Appendix A) were sent to the state criminal justice information system operators asking their judgment on what new data types they expected to see on their network in the next decade. These questions were part of the formal written questionnaire that asked for detailed traffic statistics on existing data types and for past historical trends in data volume. If the state operators of the criminal justice information system indicated there would likely be another type of data added, this statement was followed up by a phone call or visit to the agency which would provide the expected data in order to obtain better estimates of when the data might appear.

on a state system and what its volume would be over a period of time.

(2) Formal meetings were held with operators, administrators and planners of the criminal justice information systems in Texas to present the STACOM team's assumptions and forecasts for the future of the traffic volume. These "advisory committee" meetings consisted of presentations by the team members concerning the team's assessment of what future traffic in new and existing data types would be, and how this would affect the design of the state information system over the next decade. After the formal presentations, participants from all agencies were invited to discuss the material presented and offer suggestions on how the traffic projections could be made more accurate. These discussions also usually led to further individual discussions with present or potential users to obtain more accurate projections of how each agency thought its traffic level would change over the years.

(3) Individual discussions were held, often several discussions, with all of the agencies listed above. Visits were made to the state offices of all agencies involved in criminal justice and to several representative local agencies that either use or administer automatic data processing facilities. A single visit was usually insufficient to obtain all the information required to gather realistic data traffic volume projections, so several telephone calls were generally made to clarify the estimated future traffic and to obtain user response to assumptions and projections that the STACOM team had made based on earlier formal discussions or written responses.

It should be emphasized that future traffic volume estimates were usually obtained from individuals within the criminal justice community who were advocates of the effectiveness of automatic data processing, or at least convinced that it was a benefit to their agency. Criticism of the existing systems was heard from several individuals, but it was usually accompanied by suggestions for improvements that are already planned or that are likely to be made. There was no opposition to the basic idea that automatic data processing use would become more extensive in criminal justice or that it was a significant benefit to the record keeping and rapid communication required of law enforcement, court and corrections institutions.

Discussions with state agencies and with users of the state criminal justice information system were held in the context of trying to determine what could happen to traffic volume on the system over the next decade, not what should happen or what will happen. It was therefore important to get the best judgment of state officials concerning present state policies and budgets and their ideas about what future policies and budgets might be. Whenever these projections left room for scenarios that would lead to low or high traffic volumes, or to the addition of a new data type or not adding it, it was usually decided to assume the higher traffic volume so that communication lines and computers would be adequate to handle the higher load. Except for CCH/OBTS estimates, a low or high estimate for traffic in a single data type made little difference in the statewide network design or in the size of the required computing facility since these data types are projected to account for a small fraction of the total traffic volume. Thus, large variations in the estimates of traffic for these new data types have very little effect on the design of the statewide system.

In the discussions with both operators of the state systems and with the individual user agencies, questions were always asked concerning the functions of both the agency itself and of the data which were being transmitted on the statewide system. From the answers to these questions, it was possible to estimate two of the factors which are used in the following sections to forecast future traffic volumes. By obtaining a qualitative estimate of the implementation schedule for a new data type, a "technology penetration factor" was estimated which is used to specify the fraction of the total statewide potential use of the specific data type. By discussing the functions of the agency and its information needs, it is possible to estimate the number of transactions the terminals assigned to the agency will have with the state information system per arrest or per inmate per day or per court case disposition or per whatever measure is used for the agency's activity level.

User discussions also brought out whether the data used by the agencies are needed in real time or whether a slower means of transmission is acceptable. For instance, in the case of judicial statistics, it is likely that these need not be transmitted to a state judicial statistics center in near real time, but it was decided that, since large information systems are available at both the courts and at the state data center, it would be wise to connect them and avoid the cost and manual processing of the statistics by including this type of data on the state system. On the other hand, in some cases it was decided not to include certain data types on the state system because of the high cost involved for only marginal convenience or benefit. An example of this is the decision to assume that only the four or five largest cities in the state would have fingerprint volumes high enough to justify the great cost of automatic fingerprint processing equipment. Cities with smaller arrest and fingerprint volumes would therefore have to rely on facsimile transmission or communication by mail.

In Texas user and operator discussions were useful in trading off regional data bases versus a central state file and in estimating the effects this would have on the traffic over a statewide network. In Texas it was decided, for example, that court information systems that kept track of offender processing to the detail of court calendar control would best be handled on a local or regional level as it already is in several jurisdictions, and that only court statistics would be transmitted on the statewide networks. It was also assumed that the three major metropolitan areas in Southeastern Texas, Houston, Dallas-Ft. Worth, and San Antonio, would each have their own large regional data bases used by local criminal justice agencies much of the time, thus reducing the traffic on the state network.

The techniques of written survey, individual discussions with operators, planners and users of the criminal justice information system, and presentations to advisory groups of criminal justice information system experts from the model states can, of course, be used on any state and with any potential user agency in the state. Texas cooperated fully with these methods of determining their information processing needs and we believe that the projections are therefore as realistic as it is possible to be when dealing with the uncertain future.

4.3.2 Traffic Distribution

The techniques used for obtaining estimates of future statewide traffic volume were also used to project the distribution of that total data volume between the users throughout the state. As discussions were held with both state officials and data system users, comments were solicited concerning how much data traffic would flow to each of the offices of an agency. In some cases simple mechanical estimates were made such as prorating the total traffic to the correctional agency between the several institutions according to the number of inmates in each facility. In other cases the uniform proration according to arrests or offender volume was tempered by past experience to arrive at estimates that suggested, for instance, that certain facilities such as reception centers for correctional agencies generated far more information than those with no offender processing function. Thus, at the same interviews and presentations, data were obtained which allowed projections of both total statewide criminal justice information system traffic volume and the distribution of that traffic throughout the state.

4.3.4 Texas Results

Discussions with Texas officials, questionnaire responses, and the criticism of members of the Texas advisory committee suggested a slightly broader list of potential new data type users of the state criminal justice information system than in Ohio. These users are:

- Law enforcement use of a CCH/OBTS file
- Court use of the CCH/OBTS file
- Use of the state CCH/OBTS file by the Texas Department of Corrections
- Use of the CCH/OBTS files by the Texas Boards of Pardons and Paroles;
- Regional SJIS systems connected to a state system for the purpose of transmitting court statistics
- An OBSCIS system operated by the TDC and with access by the Texas BPP for the purpose of maintaining current offender release date information

An on-line system for the records of the Texas Youth Council

A network for transmitting automatically processed fingerprints from the state's largest cities to central state files

A traffic component associated with the conversion and maintenance of present manual CCH/OBTS files to computerized files.

Other types of data that were considered include a boat registration file and a file for the state parks and wildlife agency, but these types of traffic were thought to be small compared to traffic associated with other files, so these data types were not included in the analysis.

Texas already has a CCH file maintained by the TCIC which is available to all TLETS users. The file can be queried by TLETS terminals, and local users can obtain brief criminal summaries in near real time or complete criminal histories in the mail. Discussions with the operators and users of this system indicate it will be expanded and improved in the future and that it is possible for additional data elements to be added such that it could become a complete OBTS system. Although it is likely that more users who do not presently have terminals will be added in small communities and that present user data volume will increase substantially when improved faster lines and terminals are added, the system is not expected to reach its full potential utilization during the period of the STACOM study. This less than complete utilization will result from the extensive local use of regional data bases which already exist in Texas and which will allow local law enforcement officials to obtain the information they need from local files without querying the state CCH data base. For this reason the maximum use of the Texas CCH/OBTS files has been set at about half its full potential toward the end of this study period.

The TCIC also maintains the present capability to convert manual criminal histories to automated entries and to update those automated entries as manual records are received from local law enforcement agencies throughout the state. This capability is likely to remain at about the same level during the period of this study since state official point out that present Texas law requires that criminal histories be updated only upon receipt of a validated fingerprint card. This condition will probably exist for several years into the future, and, if criminal activity continues to grow as it has in the past, it would suggest that this data conversion and file maintenance traffic from the Identification and Criminal Records (ICR) Division of the Department of Public Safety (DPS) will increase also. However, in this study such traffic was kept constant on the theory that as the demand for this service grows, and as the capability of the state criminal justice information network grows, state policy will be modified to allow direct file updates from local agencies in the field. This is certainly not the present attitude of law enforcement administrators in Texas, but labor or space ceilings at the ICR Division may contribute to a change in policy.

The ICR Division is also the office of state government that would administer any system of automated fingerprint processing in Texas. In discussing this potential with DPS officials, it was learned that Texas is very interested in applying this capability as soon as a standardized system is available that would be compatible with FBI equipment. Texas officials have, in fact, held extensive discussions with several manufacturers of fingerprint processing equipment and will likely acquire such capabilities during the early years of this study period, at least on an experimental basis. Because of the high investment in equipment required, however, it is unlikely that automatic fingerprint processing and transmission to state files would ever be extended beyond the largest cities. This study, therefore, assumed that only Dallas-Fort Worth, Houston, San Antonio, and El Paso would be large enough to justify the purchase of automatic fingerprint processing equipment, and that it would be introduced gradually with Dallas-Fort Worth being the first experimental link to the DPS in Austin.

Discussions with administrators of the Texas Judicial Council, which is charged with compiling and publishing judicial statistics for the state, indicate that, because of the fragmentation and independence of courts throughout the state, any implementation of a statewide judicial information system or of extensive use of a CCH/OBTS system by the courts of Texas will be far into the future. This estimate is supported, in the opinions of the state judicial information system and state judicial statistics system planners, by the low priority given to judicial statistics by the state legislature and the consequent small budgets allowed for this function. Therefore, in this study, any use of state CCH/OBTS files by the courts, and any operation of an SJIS system to transmit court statistics from regional court data systems to the Texas Judicial Council (TJC) has been delayed until well into the next decade. However, this projection does not consider the effects of current proposals, still in the federal legislature process, that would increase federal assistance to state judicial systems. It was assumed that the court records and calendar management functions of an SJIS system would be maintained at a local or regional level in several of the largest metropolitan areas, and that only court statistics would be sent to the states. The same court terminals that were used for statistics transmission could also be used for entries and inquiries into the CCH/OBTS system. However, because of the low probability of such a system being implemented in the near future, the first operation was shown as an experimental system in the Dallas-Fort Worth area in 1983 with the other four largest metropolitan areas being added in 1985.

The Texas Department of Corrections (TDC) is an independent state agency with its headquarters remote from Austin, in Huntsville, and with an already operating, sophisticated, automatic data processing capability. Discussions with state planning personnel and with TDC data processing managers indicate great satisfaction with the present system, which is a heavily utilized batch operation with a few on-line terminals, and a reluctance to join any broader state data system to prevent unauthorized access to the TDC files. This study, therefore, assumes that, although TDC terminals will have access to state CCH/OBTS files to inquire and update offender records, no other state agencies can obtain entry into the TDC files, which will remain under the control of the TDC and be physically located in Huntsville. This projection includes corrections use of the CCH/OBTS files, and a separate OBSCIS system for the exclusive use of the TDC. The OBSCIS system control is located in Huntsville, far from the other criminal justice information system data bases. One exception to the exclusion of other state agencies from the TDC files is the Texas Boards of Pardons and Paroles, which will have access to a limited amount of inmate data so that it can compute parole eligibility dates and release dates. This will be a single interface between the BPP headquarters in Austin and one of the inmate status files in Huntsville. It is estimated that this system will first be implemented at TDC headquarters and at BPP offices near the midpoint of the 10-year study period, and that it will be fully operational to all of the TDC institutions toward the end of the study interval. This implementation estimate was applied to both the access to the CCH/OBTS files and to the OBSCIS system.

Another state agency which could use a criminal justice information system is the Texas Youth Council, which maintains homes and schools for juveniles throughout the state. The TYC does indeed automatically process much of its student and administrative data, but it is done in a batch mode on the Texas Water Development Board computer. TYC data processing administrators appear very interested in participating in a statewide criminal justice information system study. Thus, for purposes of the STACOM study, TYC traffic was assumed to start within the first few years of the study period, initially on an experimental basis from the TYC headquarters in Austin, and then to expand to all the TYC homes and schools throughout Texas toward the middle of the period. It is likely that the system would be an on-line component of the total state system, but, as in the case of the TDC, the TYC will probably control its own files to preserve the privacy of the student records.

The final state agency which would participate in the state network is the Texas Boards of Pardons and Paroles, which was mentioned previously in connection with its access to the TDC inmate records to compute inmate parole status. At the same time an interface is established with the TDC, it is likely that the BPP could also be provided access to the state CCH/OBTS file for inquiry and update purposes. The BPP would probably be a small user of the CCH/OBTS file compared to the large volume of traffic from the law enforcement agencies, but it should be included to complete the spectrum of appropriate agencies in the criminal justice process. The BPP interface with the CCH/OBTS files was assumed to coincide with its access to the TDC files at about the midpoint of the STACOM study period. The BPP already has a data processing operation in its Austin headquarters, but like the TYC, it is run batch at night on the Water Development Board computer. Presently, its inmate status program is only updated once a week by tape from the TDC file, and the Board's data processing operators are enthusiastic about implementing a more frequent on-line file updating operation.

4.4 DATA ANALYSIS TECHNIQUES AND NEW DATA FORECASTING METHODOLOGY

4.4.1 General Methodology

The components of new data that were estimated through 1985 are the nine listed in Section 4.1. Section 4.4 describes the approach taken to predicting new data type traffic in Texas. The calculations based on these techniques and the results of the calculations are given in Section 6. The procedure that was used to analyze the data gathered from the model states and to estimate future traffic was:

(1) Determine average messages per day for each component of traffic for the entire state between the user agencies and the central files

(2) Compute an average message length for each new data component for messages to and from the state files, and an average for both directions combined

(3) Determine the aggregate peak characters per minute for each component of new data for traffic to and from the state center to the users

(4) Distribute the aggregate traffic in peak characters per minute to and from the state files between the individual users of the system so that traffic volumes to the localities throughout the state can be determined.

This process is shown schematically in Figure 4-1. The following paragraphs describe how this process worked for each of the components of new data types.

4.4.2 Arrest-Dependent Traffic

4.4.2.1 <u>CCH/OBTS</u>.

4.4.2.1.1 <u>Average Messages Per Day</u>. Aggregate statewide CCH/ OBTS traffic was determined by estimating the total criminal activity in future years, determining how many offenders flow through each step of the criminal process from the criminal procedure diagram of Figure 4-2, and estimating the information needs at each step from the message use matrix of Figure 4-3. This process is shown schematically in Figure 4-4.

A complete list of the factors used in computing future CCH/OBTS traffic is given below, and the factors are explained in the following paragraphs:

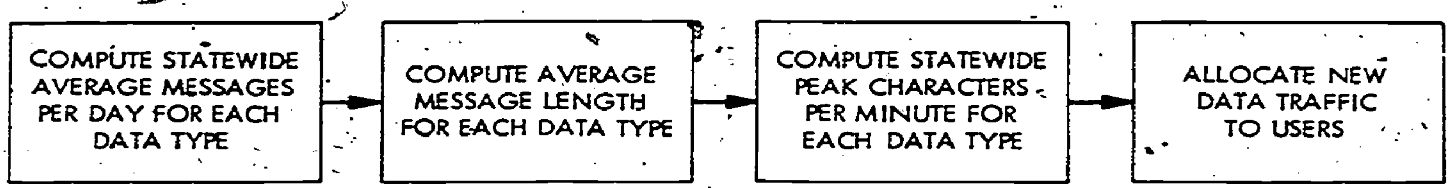
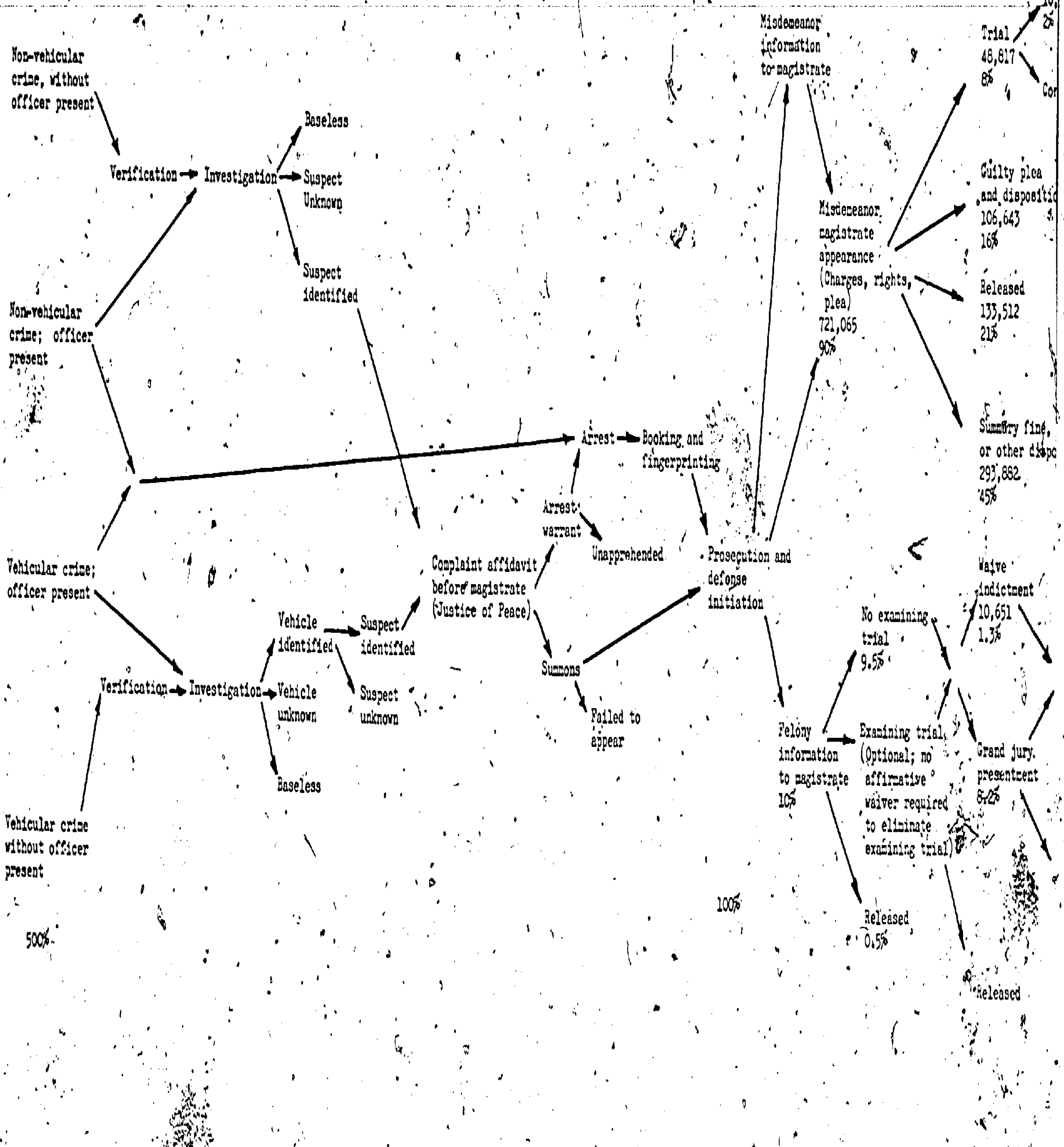


Figure 4-1. New Data Type Analysis, Forecasting and Distribution Methodology



Non-vehicular crime, without officer present
Verification
Investigation
Baseless
Suspect Unknown
Suspect identified
Non-vehicular crime; officer present
Vehicular crime; officer present
Verification
Investigation
Vehicle identified
Suspect identified
Vehicle unknown
Suspect unknown
Baseless
Vehicular crime without officer present
500%
Complaint affidavit before magistrate (Justice of Peace)
Arrest
Booking and fingerprinting
Arrest warrant
Unapprehended
Summons
Failed to appear
Prosecution and defense initiation
100%
Misdemeanor information to magistrate
Misdemeanor magistrate appearance (Charges, rights, plea)
721,065
90%
Trial
48,817
8%
Guilty plea and dispositio
106,643
16%
Released
133,512
21%
Summary fine, or other dispo
293,882
45%
Felony information to magistrate
10%
No examining trial
9.5%
Examining trial (Optional; no affirmative waiver required to eliminate examining trial)
Released
0.5%
Waive indictment
10,651
1.3%
Grand jury presentment
8.2%
Released

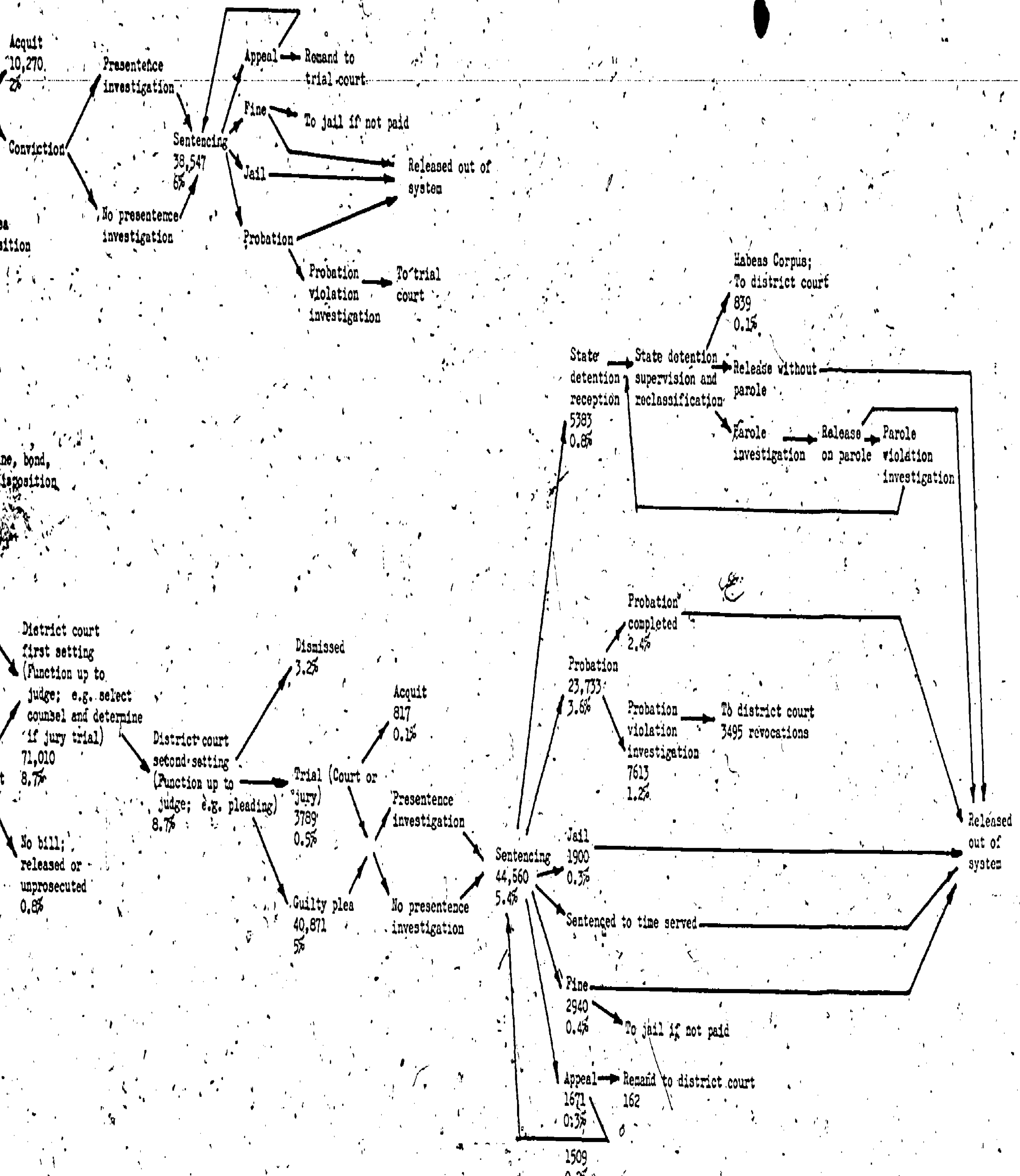


Figure 4-2. Criminal Procedure Diagram

			EXAMPLES OF CCH/OBTS TRANSACTION TYPES																							
		NUMBER OF OFFENDERS PER ARREST THROUGH EACH STEP	TCIC/NCIC SEARCH	RETRIEVE IDENTIFICATION DATA	RETRIEVE CRIMINAL HISTORY	RETRIEVE CRIMINAL SUMMARY	ENTER MASTER ID	MODIFY MASTER ID	ENTER APPENDED ID DATA	ENTER ARREST DATA	MODIFY ARREST DATA	CANCEL ARREST DATA	ENTER BAIL DATA	MODIFY BAIL DATA	VALIDATE MASTER ID	VALIDATE APPENDED ID DATA	VALIDATE ARREST CHARGE	VALIDATE JUDICIAL HISTORY	ENTER LOWER COURT DATA	MODIFY LOWER COURT DATA	ENTER FELONY COURT DATA	MODIFY FELONY COURT DATA	ENTER JUDICIAL COUNT	ENTER SUPPLEMENTAL COUNT	ENTER CUSTODY/SUPERVISION	MODIFY CUSTODY/SUPERVISION	TOTALS
POLICE 16.0	INCIDENT VERIFICATION	5.0	0.1	0.1		0.1																					0.3
	INCIDENT INVESTIGATION	5.0	0.5	0.5		0.5																					1.5
	SUSPECT IDENTIFICATION	5.0	2.0	2.0	0.1	0.5																					4.6
	COMPLAINT AFFIDAVIT	1.0	0.5	0.5		0.5																					1.5
	BOOKING AND FINGERPRINTING	1.0	1.0	1.0	0.2	1.0	0.4	0.6	0.1	1.0																	5.3
	ARREST VALIDATION	1.0													1.0	0.1	1.0										2.1
	BAIL SETTING	1.0											0.5	0.1													0.6
	DETENTION	1.0																							0.1		0.1
PROSECUTION 3.3	PROSECUTION REVIEW	1.0	0.1	0.1	0.1	0.5					0.2	0.2							1.0	1.0	0.1						3.3
LOWER COURTS 4.09	MISDEMEANOR COURT PROCESSING	0.9	0.1	0.1	0.1						0.1	0.1							0.9	0.5							1.9
	MISDEMEANOR SENTENCING	0.06	0.06	0.06	0.01	0.06														0.9			0.1	0.1			1.29
	MISDEMEANOR DISPOSITION VALIDATION	0.9																0.9									0.9
JAIL 0.03	MISDEMEANOR CUSTODY	0.01				0.01																			0.01	0.01	0.03
PROBATION 0.21	MISDEMEANOR PROBATION	0.05			0.01	0.05																			0.05	0.1	0.21
FELONY COURTS 1.99	FELONY INFORMATION	0.1	0.1	0.1		0.1													0.1	0.1							0.5
	FELONY GRAND JURY PRESENTMENT	0.095	0.1	0.1		0.1					0.1	0.01										0.1					0.51
	FELONY FIRST SETTING	0.087									0.1	0.01									0.1	0.1					0.31
	FELONY SECOND SETTING	0.087									0.05	0.01										0.2					0.26
	FELONY TRIAL	0.005										0.01										0.02	0.01	0.01			0.05
	FELONY SENTENCING	0.054	0.05	0.05	0.01	0.05																0.05					0.21
	FELONY APPEAL AND HABEAS CORPUS	0.004	0.01	0.01	0.01	0.01																0.01					0.05
	FELONY DISPOSITION VALIDATION	0.1																0.1									0.1
PROBATION 0.37	FELONY PROBATION	0.036	0.04	0.04	0.01	0.04																			0.04	0.2	0.37
CORRECTIONS 0.25	FELONY CUSTODY	0.008	0.01	0.01	0.01	0.01																			0.01	0.2	0.25
PAROLE 0.24	PAROLE	0.008	0.01	0.01	0.01	0.01																				0.2	0.24
	TOTALS		4.68	4.68	0.57	3.54	0.4	0.6	0.1	1.0	0.55	0.34	0.5	0.1	1.0	0.1	1.0	1.0	2.0	2.5	0.2	0.48	0.11	0.11	0.21	0.71	26.48

Figure 4-3. Texas Message Use Matrix

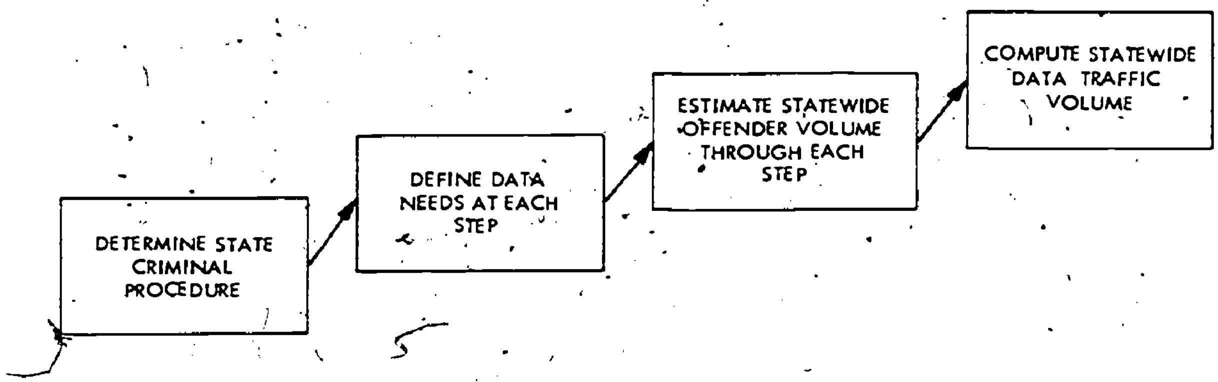


Figure 4-4. Traffic Forecasting Process

Total Statewide CCH/OBTS Traffic in Average Messages per day = Estimated statewide arrests per year
× Technology penetration factor
× Number of transactions with the CCH/OBTS files per arrest
× Number of messages per CCH/OBTS transaction
× Time conversion to convert from years to day

For purposes of this study, statewide arrests were projected to increase linearly at a rate equivalent to about 2% of 1975 arrests per year between 1975 and 1985. This has been the national rate of increase during the past decade, although this growth has been very erratic. Figure 4-5 shows national arrest trends over the past decade based on figures from the FBI Uniform Crime Reports (UCR) and "United States Statistical Abstracts." The upper curve is estimated total arrests throughout the nation while the bottom line is actual reported arrests. As noted in the figure, estimated total arrests were either computed by the FBI using information about the population and arrest statistics of jurisdictions that do and do not report arrests or they were computed in the course of this study (those with a subscript "c") by multiplying actual arrests reported by the ratio of total national population to population in the jurisdictions reporting arrests. These reported arrests grow at approximately 6.2% per year, but much of that increase must be caused by improved reporting since the estimated actual arrests only grow at linear rate of about 193,000 arrests per year, which is 2.08% of the 9.27 million estimated arrests in 1975. This growth rate in arrests was then applied to Texas, which yielded an arrest increase of 11,286 per year from the 542,574 arrests in Texas in 1975.

Consideration was given during this study to using total FBI index crimes as a method of projecting future criminal justice information system traffic. However, traffic will likely be a function of police activity as measured by arrests, rather than of criminal activity as measured by reported crimes, since it is the criminal justice agencies using the information system that generate traffic, not the offenders or victims of crime.

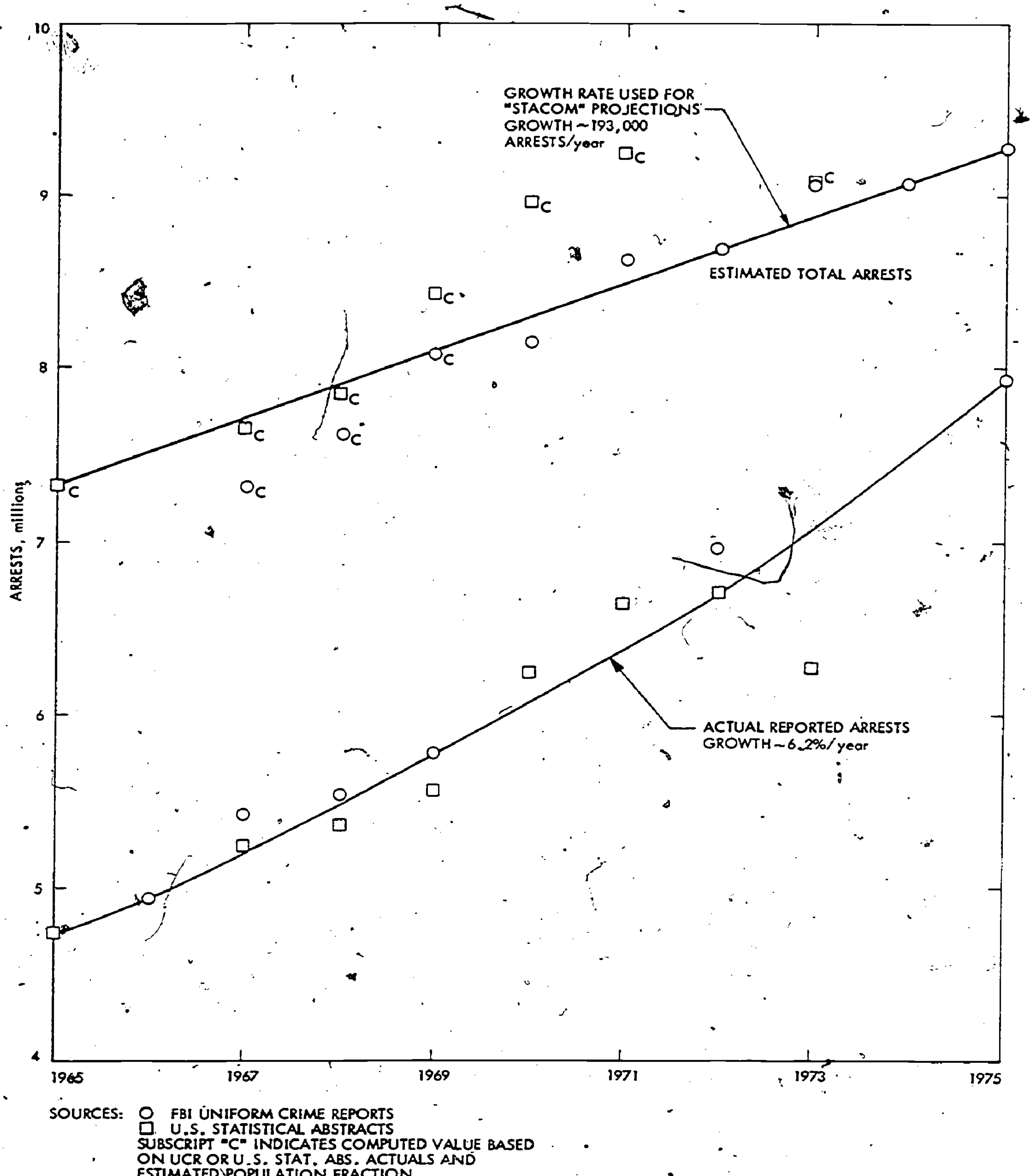


Figure 4-5. National Arrest Trends

Total arrests in Texas were computed from FBI UCR data in 1975, which showed that, on a national level, 0.82 arrests for felonies and nontraffic misdemeanors were made per index crime. This ratio was applied to the index crimes estimated for Texas in 1975 to determine the estimated statewide arrests.

The technology penetration factor accounts for the extent to which hardware is available to users, for the gradual familiarization process user agency personnel go through, and for the availability of funding to implement the several types of new data. In most cases, this factor, which varies from 0 to 1, was estimated based on the suggestions of state criminal justice information system experts about when the several types of new data would be implemented in the state. In Texas, the technology penetration factor for law enforcement use of the CCH/OBTS system reaches a peak of 0.5 since it is assumed that local computer systems in the major cities will be used in many cases, thereby avoiding the need to use the state system.

The number of transactions with the CCH/OBTS files can be determined by estimating the number of transactions per arrest from Figure 4-3. The criminal procedure flow diagram of Figure 4-2 shows the number of offenders through each step in the criminal justice process per arrest, and Figure 4-3, the messages use matrix, uses this information to derive the information needs at each step, per arrest. Multiplying by the total number of arrests in the state yields the total transactions with the CCH/OBTS files. Summing these transaction volumes over any part of the criminal justice establishment - say courts or corrections, for example - one can then compute the traffic generated by each institution.

The number of transactions with the CCH/OBTS files per arrest will be noted to be quite high, especially for law enforcement and court activity. In the case of law enforcement, this is caused by the expected large number of inquiries prior to arrest that never result in an arrest. Statistics from the FBI Uniform Crime Reports for 1975 show that only 21% of index crimes were cleared by arrests, implying that most crimes are not cleared by arrests or that arrests that are made do not clear crimes and result in dropped charges. Thus, in deriving the message use matrix and assigning the number of transactions per arrest that occur prior to an arrest, a large multiple is included to account for these interactions with the state criminal justice information system that never result in arrests. In the case of the courts, the relatively large number of transactions per arrest is due to the multiple hearings and appearances, including continuances and re-hearings that are part of the judicial process. Both in the case of law enforcement and judicial interaction with the state data system, the values derived in this study are close to those estimated independently by Texas officials.

Since each transaction requires a message to the state files and an accompanying response, there are two messages per transaction. This accounts for an inquiry and response for each inquiry transaction, and an update and acknowledgment for each data entry transaction.

The time conversion factor is either 365 days per year for law enforcement agencies or 250 days per year (to delete weekends and holidays) for other agencies. This factor is necessary to convert from total arrests per year to messages per day.

4.4.2.1.2. Average Message Length in Characters. Average message length of CCH/OBTS traffic is computed by weighting the length of the various types of messages by the fraction of the traffic that each message type provides. Inquiries are considered to be brief: usually one to three lines of whatever high-speed terminal is in use. Responses can be of widely varying length, depending upon whether the inquiry resulted in a "hit" or "no-hit." "Hit" responses are taken as a large fraction of a terminal page - perhaps 1000 characters - while the percentage of "no-hit" responses and their length are derived from the experience of the operators of the present state systems, or from their estimate of future traffic. The fractions of message types generated by the various institutions in the criminal justice system - e.g., the fraction of data entries by law enforcement agencies or the fraction of inquiries into the CCH/OBTS system by the courts - are derived from the message use matrix of Figure 4-3. The weighted message lengths are then summed to obtain: 1) average message length to the central state files, 2) average message length from the state files to the users, and 3) the average length of messages traveling both directions on the state network.

4.4.2.1.3 Peak Traffic in Characters Per Minute. Traffic volume in average messages per day has been computed above, and this can be converted to peak characters per minute by multiplying by average message length and several other time and peak-to-average conversion factors. The complete relationship between average messages per day and peak characters per minute is:

CCH/OBTS traffic in peak characters per minute = Average messages per day

x Peak-to-average ratio (taken as 2 throughout this study)

÷ Number of messages per transaction to or from the state files (taken as 2 throughout this study because inquiries generate responses and entries generate acknowledgments)

÷ Time conversion factor for changing daily rate to rate per minute (taken as 1440 minutes per day for law enforcement inquiries and updates and 480 minutes per day for all other traffic)

x { Average message length to state files or Average message length from state files }

= { Peak characters per minute to state files or Peak characters per minute from state files }

The peak-to-average ratio of 2 was determined by obtaining current daily traffic statistics from Texas, computing the daily average traffic volume, and observing that the average was about half the peak traffic.

This technique for converting average messages per day to peak characters per minute was used for all new data types considered in this study. Different message lengths and time conversion factors were used where appropriate, but peak-to-average ratio and the number of messages per transaction always were assumed to be 2.0.

4.4.2.1.4 <u>Traffic Distribution to User Agencies</u>. The final step in predicting criminal justice information system traffic from new data-types is the distribution of the traffic to the local users throughout the state. This calculation is done by computer in the case of law enforcement use of CCH/OBTS files, because there are several hundred law enforcement terminals in Texas presently connected to the state systems. The distribution of CCH/OBTS traffic to courts, corrections, or parole agencies is done manually, since, in the early years, there is usually only one regional terminal or headquarters terminal operating, and when the systems are completed there are not usually more than a dozen terminals.

New data traffic to law enforcement agencies is distributed according to the ratio of index crimes in the jurisdiction served by the agency to the total number of index crimes in all appropriate jurisdictions with terminals. This traffic is distributed to local police and sheriff departments and is not assigned to state police stations or federal offices. Traffic from these other offices is allowed to grow at a rate predicted by the growth algorithm for existing data types. The existing data traffic and new data type traffic are then added for each terminal, and the result printed for review and provided to the network designers on tape. Distribution of law enforcement CCH/OBTS traffic according to index crimes in each jurisdiction was made because such data are readily available each year from both state and national law enforcement statistics agencies and because criminal activity is a reasonable measure of the need for information in law enforcement agencies. Other measures such as the number of personnel in a local law enforcement office or the population, or the number of arrests in the jurisdiction could be used, but, except for raw population data, these other measures are less readily available and less current, so distribution was made according to local index crimes.

Court CCH/OBTS traffic is distributed according to the population served by each of the regional court systems in Texas. One region is assumed to be an experimental facility in the early years and the remaining large metropolitan areas are added within a few years.

Traffic between the corrections facilities and the CCH/OBTS files is distributed according to the number of inmates in each institution, except that a larger percentage of traffic is assigned to the corrections department headquarters.

Any traffic to or from the state parole agency was assumed to flow entirely between that agency's headquarters and the state CCH/OBTS files.

4.4.2.2 Automated Fingerprint Traffic.

4.4.2.2.1 Average Messages Per Day. Within the next decade it is anticipated that Texas will implement some sort of automated fingerprint encoding, classification, and transmission process. It is likely, however, that equipment for this will be available only in the largest cities since it is quite expensive and requires a large fingerprint volume to justify it. For this reason, the factors used for computing the average fingerprint message volume per day, which are the same factors used in the relationship of Section 4.4.2.1.1 above, include a technology penetration factor that begins with just one large city participating in the program in the early years and expands to several of the largest metropolitan areas at maturity.

The number of fingerprint transactions per arrest is an estimate based on 1973 FBI crime statistics which showed that about 21.2% of index crimes were closed by an arrest, or 4.72 crimes were committed per arrest. If latent fingerprints are associated with 25% of these crimes, approximately 1.18 fingerprints would be transmitted per arrest for the purpose of identifying the latent print. In addition, every arrestee would be fingerprinted and a 10-print card would be processed and sent to state files. The total number of transactions including both latents and full cards, then becomes 2.18 per arrest.

As with the CCH/OBTS average traffic volume, two messages per fingerprint transaction are assumed because each transaction would include a message to the state files and an acknowledgment. Fingerprint transmission was assumed to take place during a normal work week, so a value of 250 working days per year was assumed for the time conversion factor.

The other factors used in the computation of average fingerprint volume per day are the same as those used in the derivation of average CCH/OBTS traffic in Section 4.4.2.1.1.

4.4.2.2.2 Average Message Length. To compute average message length for digital fingerprint transmission, a decision must first be made about which steps in the fingerprint processing should be performed in the local agency and which steps should be done at a central state facility. The process for fingerprint analysis based on the analysis of minutiae (ridge ends and ridge bifurcations) is shown in a simple schematic in Figure 4-6.

The data volumes shown are those for systems such as those sold by Rockwell International, Anaheim, California, and Calspan Technology Products, Buffalo, New York. The Sperry system presently in use in Arizona produces an 8-bit byte of information at every point of a 30 x 30 matrix on each print, based on ridge slope analysis. The 72,000 bits thus generated for each set of 10 prints are then reduced to 240 8-bit bytes per card for permanent storage. For the purposes of this study, the Rockwell-Calspan system was assumed to be the one that would

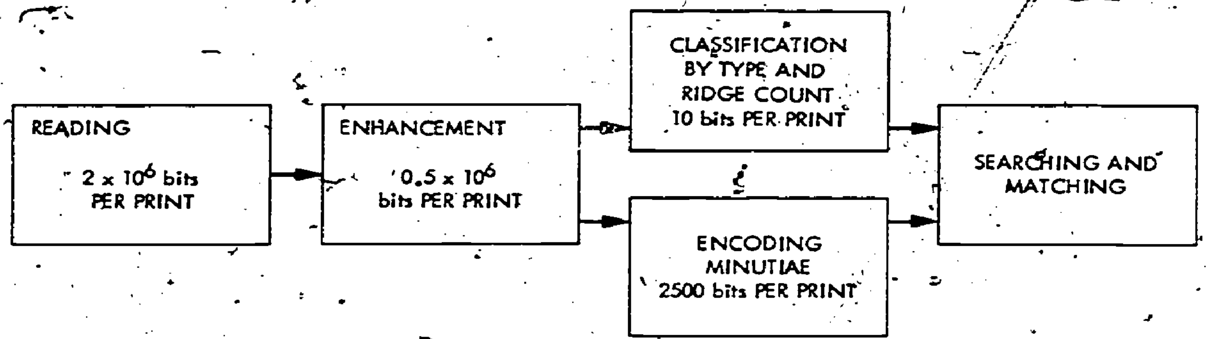


Figure 4-6. Automated Fingerprint Processing Diagram

be used, because it would produce a larger volume of data and would therefore yield a conservatively designed system.

The alternative to transmitting 2 million or 0.5 million, or 2,500 bits per print from a minutiae-based processor to a central file is to have only one minutiae-based system at a central location and send raw or enhanced fingerprints from the remote agencies by digital or analog facsimile equipment such as that manufactured by Harris Corp., Melbourne, FL, or by Dacom, Inc., Santa Clara, CA. Such equipment presently scans fingerprint images at between 100 and 400 lines per inch, quantizes the gray scale into 2 to 16 shades (1 to 4 bits), and compresses the data by a factor of 2 or 3. This still leaves on the order of a few million bits that must be transmitted per 8-in. x 8-in. fingerprint card. Over a 2400-baud line, this takes about 10 to 20 minutes which would allow a few dozen cards to be processed per 8-hr work day at each terminal. This is inadequate for a large police agency like Cleveland which had 52,022 index crimes committed in 1974. If we assume 0.82 felony and misdemeanor arrests per index crime (the 1975 nationwide ratio from FBI UCR reports), and a growth rate of 900 arrests per year (the average nationwide rate applied to Cleveland) Cleveland would have 52,558 arrests in 1985 or 210 arrests per work day. If we further assume that every arrest requires that a set of fingerprints be sent to the central files, this is 210 sets of fingerprints per day. In addition, if we assume that there are 4.72 felonies and misdemeanors per arrest, and that 25% of these crimes have latent prints associated with them, this is an additional 1.18 prints per arrest that must be sent to the state files. The resulting 400 or more images that must be sent each day are therefore not compatible with a facsimile capability that requires 10 or 20 minutes per image. Note that facsimile speeds are now approaching 1 minute per fingerprint card from some vendors, but even this speed would only marginally satisfy the needs of a large city in the next decade.

The answer to this problem might be to use special wideband microwave links between the major cities and state files. This, however would remove fingerprint transmission from the state telecommunications network to such a special high data rate system. For the purposes of this study, therefore, it was decided to assume that the largest police agencies would each have equipment to read, enhance, encode minutiae, and classify fingerprints, so that they would only need to transmit about 2500 bits per print to the central state facility, which could be done over a lower speed state telecommunications line. This analysis is supported by one manufacturer who suggests that having a reader/classifier is appropriate for agencies processing more than 50 fingerprint cards per day, serving populations about 0.5 million. He estimated each reader/classifier would cost about $150,000.

With this decision, average message lengths for fingerprint transmission were computed by assuming that one full 10-print card and 1.18 latent prints were transmitted per arrest. A card was assumed to require 25,000 bits (2500 characters) for the 10 prints plus 960 characters for the alphanumeric data. The response was assumed to require 240 characters. For transmission of latent prints, one print was assumed to require 2500 bits (250 characters) plus 240 characters of alphanumeric data. The response was calculated by assuming 10% hits at 960 characters and 90% no-hits at 240 characters for an average of 312 characters. Averaging both types of transactions over the 2.18 transactions per arrest yields the average message lengths of Table 4-1.

Table 4-1. Computation of Average Automated Fingerprint Message Length

Message Type	Transactions Per Arrest	Message Length in Characters		Weighted Message Length Computation		
		To State Files	From State Files	To State Files	From State Files	To and From State Files
Card input	1.0	3,460	240	1,587	110	849
Latent input	1.18	490	$\left\{\begin{matrix} 0.1 \times 960 \\ 0.9 \times 240 \end{matrix}\right\}$	265	169	217
Totals	2.18			1,852	279	1,066

4.4.2.2.3 Fingerprint Traffic Distribution. Automated fingerprint traffic was distributed in Texas according to the population of the major metropolitan areas having the equipment required to process the prints. It was assumed that the largest city would obtain the necessary equipment earlier than the others, but that several of the largest areas would be processing prints automatically by 1985.

4.4.3 Offender-Dependent Traffic

4.4.3.1 OBSCIS.

4.4.3.1.1 Average Messages Per Day. The OBSCIS system is devoted almost exclusively to the needs of the departments of corrections, with the exception that in Texas the BPP will be able to access the inmate commitment records to compute current parole status. OBSCIS traffic will be from the several corrections institutions to the corrections department's headquarters. In Texas, the TDC is in Huntsville, remote from other state agencies. This is therefore a new location for a data base in Texas, since most of the other traffic flows to and from data bases in Austin.

Instead of being based on the number of arrests, OBSCIS traffic is determined by the number of transactions with the system per inmate-day. An estimate is made of the frequency of inquiry or update for each inmate, and this is converted to the number of transactions per inmate-day. The relationship for converting this to average messages per day is:

OBSCIS traffic in average messages per day = Total inmates in corrections department

x Technology penetration factor

x Transactions per inmate-day

x Messages per transaction

The number of inmates in state correctional institutions was assumed to grow at a rate estimated by state correctional-system planners. In Texas, state planners provided an estimate of 28,000 inmates in 1980 and 37,000 in 1985 from a 1976 level of 21,000 inmates.

In Texas, implementation of an OBSCIS system on a state network was estimated to take place after 1980, although Texas presently has data processing capabilities in their headquarters. For purposes of estimating communications traffic, however, the technology penetration factor does not reach a significant value until early in the next decade. For the first few years, the traffic was confined to the headquarters office, or to the headquarters office and the reception centers. Toward the end of the study, the traffic on the state network was distributed to the institutions.

The number of OBSCIS transactions per inmate-day was estimated by picking the frequency of transactions for each inmate and converting this to a number of inquiries or entries per inmate-day. In general, it was assumed that an inquiry and a record update would occur for each inmate every 2 to 4 weeks. This rate of between 2 transactions per 2 weeks and 2 transactions per month implies between 0.07 and 0.14 transactions per inmate-day. This range of values was used for this parameter in Texas.

All new data type traffic was assumed to generate a response for every inquiry and an acknowledgment for every update, which means two messages are generated by every transaction.

4.4.3.1.2 Average Message Length. OBSCIS average message lengths are again computed by weighting the types of messages according to how frequently they are sent. The lengths of each transaction type are multiplied by the fraction of total transactions per inmate-day used for that data type, and the results summed for messages to the corrections departments' headquarters, from the headquarters, and for an average in both directions.

4.4.3.1.3 OBSCIS Traffic Distribution. In later years when the OBSCIS system is assumed to be fully operational throughout the state and using the state communications system, traffic is distributed between the institutions by the number of inmates in each facility. In addition, a slightly larger proportion of traffic is assigned to the reception centers and headquarters, and, in Texas, access is also provided to the BPP so that it can have commitment records available for use in computing parole status. In the early years of an OBSCIS system, traffic is assumed to come only from the headquarters of the corrections department or from the reception centers.

4.4.3.2 Juvenile Institutions.

4.4.3.2.1 Average Messages Per Day. Only the data traffic of the Texas Youth Council (TYC) was considered in the new data types for the state communications system. Traffic on lines serving TYC homes, schools, and headquarters will be devoted exclusively to TYC use. The TYC presently runs its programs batch at night on the Texas Water Development Board Computer and uses this capability for student records and administration functions such as personnel records and accounting. The average daily message volume was based on the number of transactions per student-day just as OBSCIS traffic volume was. The expression for average messages per day is therefore the same as that given in Section 4.4.3.1.1 above.

There were about 1,800 TYC students in 1975, and this number was assumed to increase linearly at the same fractional rate as state officials estimated for the TDC inmate population. TDC population was projected to increase by about 80% over the next 8 years, so TYC student population was assumed to grow from 1,835 to 3,280 over the same period.

Because the TYC already has a batch automatic data processing capability, its addition to the state system could occur quite rapidly.

The technology penetration factor was therefore put at 0.5 in 1979, and 1.0, meaning full utilization, in 1981 and thereafter.

TYC data processing personnel provided an estimate of 0.26 transactions per student-day for expected traffic volume on an on-line data system. This is equivalent to an average of one message per student every four days. Although it seems to be a high value, it is probably appropriate when considering administrative messages as well as student records.

As with all other data types, two messages were assumed per transaction to account for acknowledgments to data entries and inquiries.

4.4.3.2.2 Average Message Length. TYC average message lengths are computed identically to OBSCIS messages. Message types are weighted according to how frequently they are sent, and the results are summed for messages to the TYC headquarters, from the headquarters, and then in both directions.

4.4.3.2.3 TYC Traffic Distribution. In 1979, TYC traffic was assigned completely to the headquarters office since it was felt that the system would be new and experimental. In 1981 and thereafter, one quarter of the traffic was assigned to the headquarters office and to the Brownwood reception center, and the remainder was prorated between the homes and schools according to the number of students in each.

4.4.4 Other New Data Types

4.4.4.1 State Judicial Information System.

4.4.4.1.1 Average Messages Per Day. Instead of being based on the number of transactions per arrest as CCH/OBTS traffic is, or the number of transactions per person-day as is traffic in the OBSCIS and juvenile institutions, SJIS traffic is estimated based on the number of transactions per court disposition including both criminal and civil cases in the courts that handle felonies and non-traffic misdemeanors. The algorithm for computing SJIS traffic is:

SJIS traffic in average messages per day = Number of criminal and civil dispositions per year from courts that handle felonies and non-traffic misdemeanors

x Technology penetration factor

x Transactions per disposition

x Messages per transaction

x Time conversion factor from years to days

The growth in court dispositions was assumed to be linear in Texas, and the annual increase was based on the growth rate for the past several years. This was about 5% of the 1975 dispositions in Texas. This rate of growth was then extended linearly to 1985.

The technology penetration factor was chosen to reflect the fact that the SJIS system would likely be implemented first in one major metropolitan area and then expanded into a few other large cities. This factor therefore reflects the proportion of the population served by the SJIS system as it expands from the first trial city to other areas of the state in Texas.

Since all SJIS case tracking, record keeping, and calendar setting functions are assumed to be confined to the local level, and the state-level traffic will be limited to statistical reporting, the number of transactions per disposition has been taken as 1.0. This does not mean that every case will be reported once, but that the average volume will be at that level.

As with the other traffic types, each SJIS transaction generates a data entry and response, so two messages are generated per transaction. The time conversion factor assumes that there are 250 court days per year.

4.4.4.1.2 Average Message Length. Since SJIS messages are statistical inputs, they are assumed to consist of a large amount of data sent to the state data center followed by a brief acknowledgment. In Texas, therefore, messages to the state data center are taken as one page in length, followed by only a few lines of acknowledgment.

4.4.4.1.3 Distribution of SJIS Traffic. In Texas, because of the overlapping judicial districts and counties, it is difficult to assign the volume of dispositions to a standard metropolitan area. For this reason, SJIS traffic was prorated according to the population in each of the standard metropolitan areas. In the first year of operation, traffic was assigned to the one experimental city.

4.4.4.2 State Data Conversion.

4.4.4.2.1 Average Messages Per Day. Texas has offices that convert the thousands of existing criminal histories to automatic records, and that enter current offenders into the files, since field users are not yet able to do so. In Texas the office is the Identification and Criminal Records Division of the Department of Public Safety in Austin. Traffic from this agency into the state criminal history files was taken as the current level or a value that state officials estimated would be reached in the near future. The traffic level was kept constant between the present and 1985 because it was assumed that, as a gradual increase in criminal activity takes place, an increasing number of updates to the records will be made directly from user terminals, thereby avoiding the data conversion process at the state criminal records agency. Texas provided current traffic levels in numbers of transactions per day. This value can be multiplied by the number of messages per transaction to get the average number of messages per day, as was done with all new data types analyzed previously.

4.4.4.2.2 Average Message Length. Average message length from the many terminals in the central state facilities was likewise computed just as it was for the other data types. Each message type was weighted by the fraction of the time it was sent, and the resulting sum over all messages going to the state files, from the state files, and in both directions yielded the average lengths in characters for each direction. Most messages from the criminal records center to the state files are data entries, and these were taken as a whole page of the terminal. Acknowledgments were assumed to be a few lines at most. If, before updating an offender's file, an operator desires to inquire whether the offender is a new entry or a recidivist and already in the files, this inquiry was assumed to be a few lines and the response a major fraction of a page. No distribution of this traffic to other state agencies is required since the only source is the group of terminals in the state criminal records agency.

SECTION 5

COMBINATION OF NEW AND EXISTING DATA TYPES

The traffic projections for existing data types in Section 3, and those for new data types in Section 4 were developed under the assumption that there were no information system hardware or software constraints to traffic growth. In both cases it was assumed that computer capacities were sufficient to handle as much traffic as the users could generate. In this section, the traffic demands are added together and constraints are applied, to impose realistic limits to the volume of allowable traffic based on the capacity of the central computers processing the criminal justice messages.

Besides being assumed to be unconstrained, the new and existing data types were each computed assuming complete independence. For instance, an assumption was made that the volume of inquiries into the wanted persons files from a local law enforcement terminal did not affect the traffic into the CCH/OBTS files when these files are made readily available and are in wide-spread use. In this case, the new CCH/OBTS traffic was assumed to be independent from the existing traffic into the wanted persons files. This assumption of independence also extended to other existing data types such as license plates and drivers and to all the new data types from law enforcement, to courts, corrections, and parole agencies.

The assumption of independence between the data types allowed the projected traffic simply to be added together throughout the period of the study. This traffic sum was then the total traffic throughout the state, except in the cases in which the total statewide traffic from new and existing data types approached or exceeded the capacities of the central computers. In this situation, the total traffic level was reduced slightly below the capacity limit as it approached saturation, an assumption was made that the computer capacity was increased significantly, and the traffic growth was then allowed to continue in an unconstrained fashion. After the computer upgrade, new data traffic was even allowed to accelerate beyond its expected growth rate to include the traffic that was not included during the period near saturation.

This process of constraining traffic growth as it reaches the computer capacity is illustrated in Figure 5-1. Unconstrained projected traffic is computed for each 6-month period throughout the study. When the expected unconstrained traffic exceeds the computer capacity, it is reduced to 1 to 2% below the capacity limit. In the next 6-month period it is assumed that the computer installation has been upgraded significantly and presents no constraint to traffic growth. In the period following the upgrade, the growth rate in baseline existing data types displays the slow growth characteristic because of the newness of the system. The new data types and existing data type traffic affected by system improvements are allowed to grow at their expected unconstrained rate, and an additional increment from these new data types and existing traffic affected by system improvements is included in the period following an upgrade.

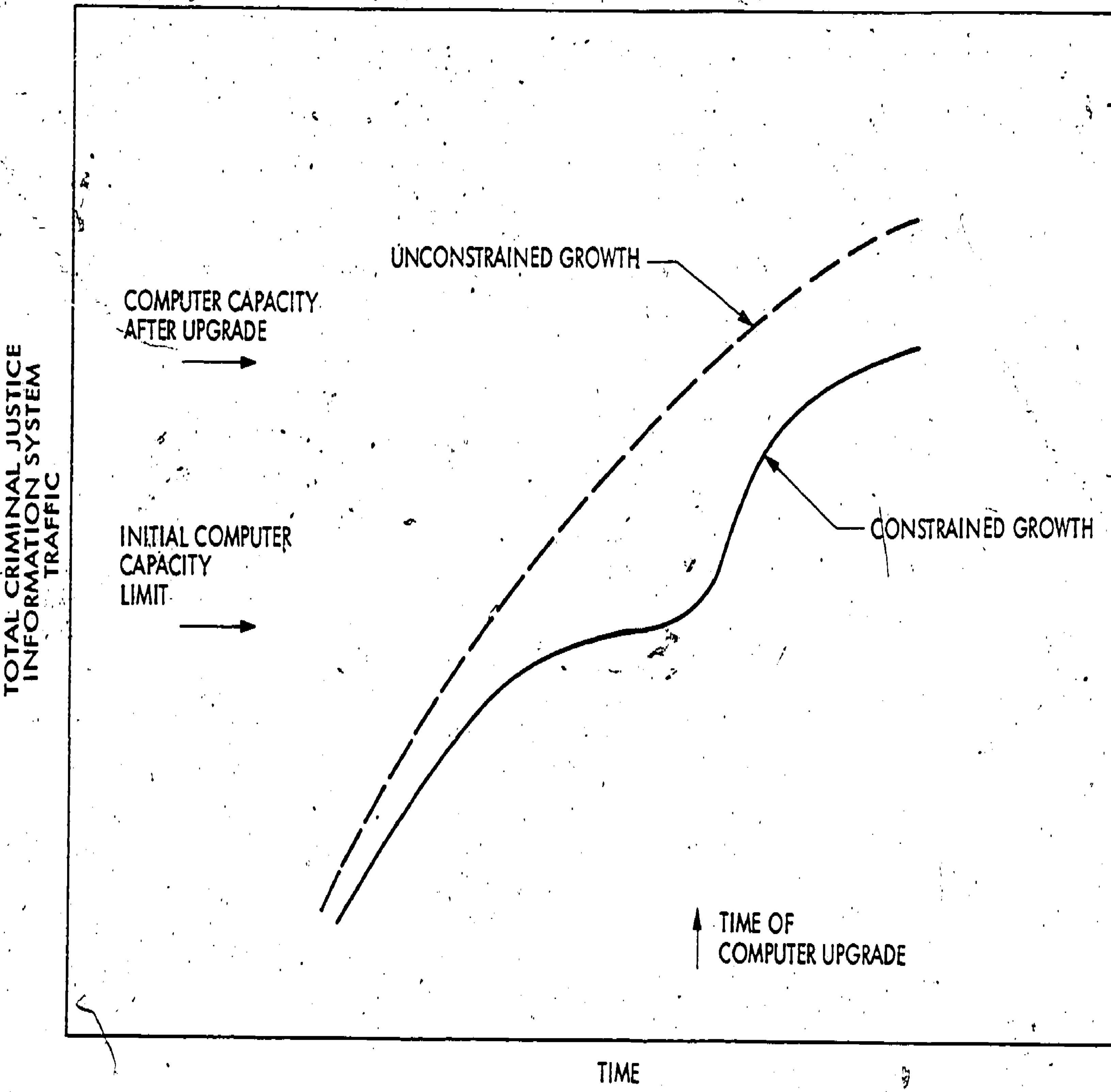


Figure 5-1. Total Statewide Traffic Growth Constrained by Computer Capacity

This additional increment equals the difference between the unconstrained traffic in the saturation period and the constrained traffic during that period.

The details of this process of adding new data traffic to existing traffic are shown for all the 6-month periods of the study for Texas in Section 6. The aggregate totals for Texas are shown in summary form in the tables of Section 1. Table 1-1 shows total criminal justice information system traffic in Texas every 2 years between 1977 and 1985. Traffic volumes are given in both average messages per day and in peak characters per minute. The curves in Figure 1-3 present the same traffic growth information of the table in graphical form.

120

SECTION 6

TEXAS TRAFFIC MODELING

This section presents more detailed information on the traffic modeling and distribution techniques developed in Texas. Planners in Texas will find this section useful as it discusses details of our analysis that apply uniquely to their state. The general reader may find it interesting to observe the types of problems to be encountered when trying to apply the methodologies discussed in Sections 3 and 4 to a particular state. Methodologies, data, and data analysis discussed in Sections 3 and 4 will not be presented again in this section. Instead we will refer the reader to the appropriate part of Section 3 or 4.

6.1 EXISTING DATA TYPES

6.1.1 Data Gathering

In Section 3.2 there was a discussion in general terms of the data collection results. This section will present in further detail the data collected from Texas in response to the state level questionnaire and the user agency questionnaire. Recall that copies of these questionnaires are contained in Appendices A and B. Readers should interpret this data as the basic set of information required to perform the existing data type analysis.

Responses to the Texas state level questionnaire follow:

<u>Question 1</u>

Texas provided us with a very complete response to Question 1 which included descriptions of system configuration for every year from 1971 through 1976 and reports on all changes made to the system during this period. This detailed information helped us to precisely define past and present system configurations.

Parts of the response describing the 1976 Texas Law Enforcement Telecommunication System (TLETS) are shown in Figures 6-1, 6-2, and 6-3. Figure 6-1 shows the 75 baud communication line configuration. The large dark circles represent switchers and are located in Garland/Dallas, Austin and San Antonio. Figure 6-2 shows 110, 1,200 and 2,400 baud circuits. Note that the majority of users are currently served by low-speed circuits. Figure 6-3 shows all existing TLETS circuits.

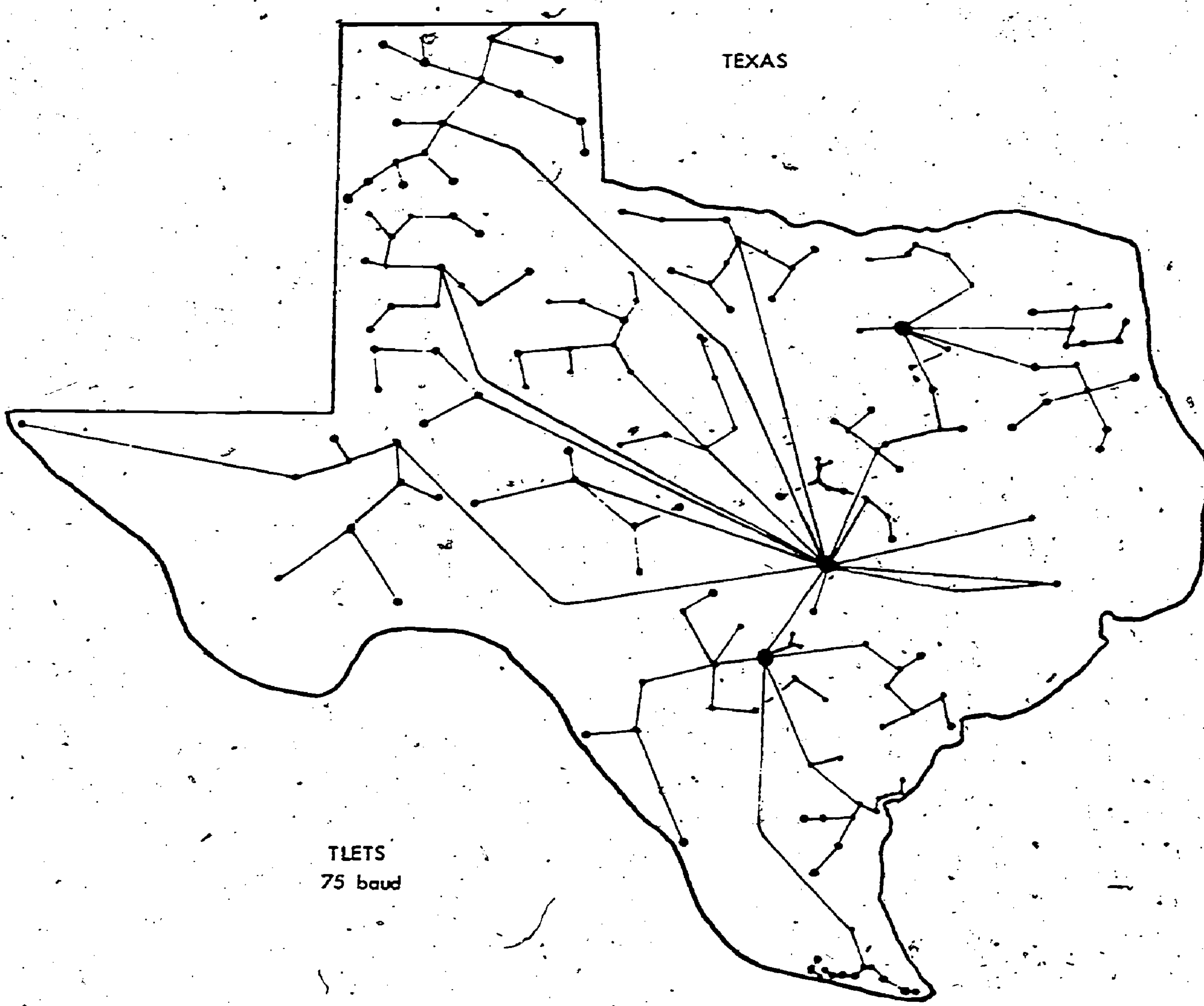


Figure 6-1. TLETS 75 Baud Circuit Configuration

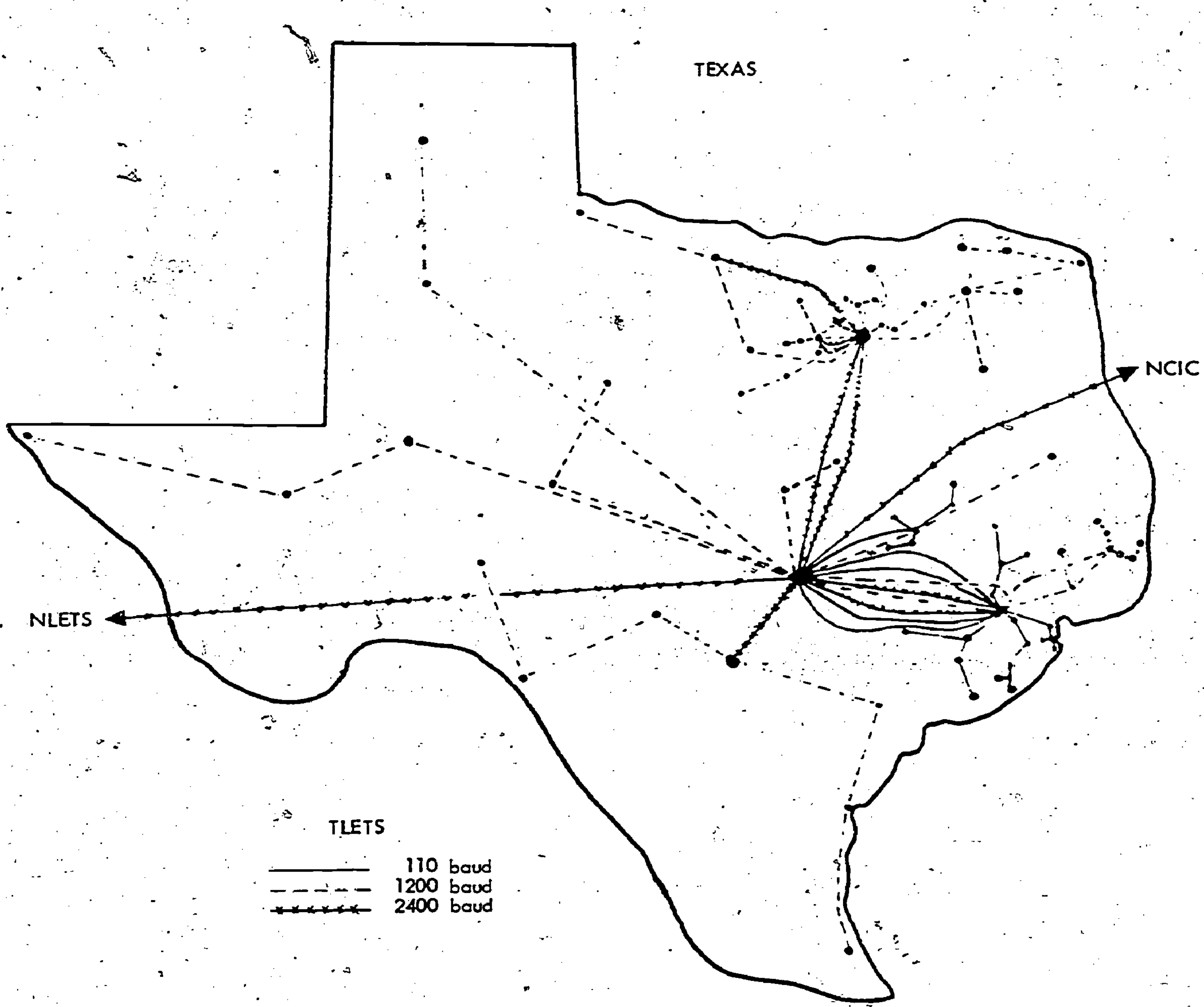


Figure 6-2. TLETS 110, 1200, and 2400 Baud Circuit Configuration

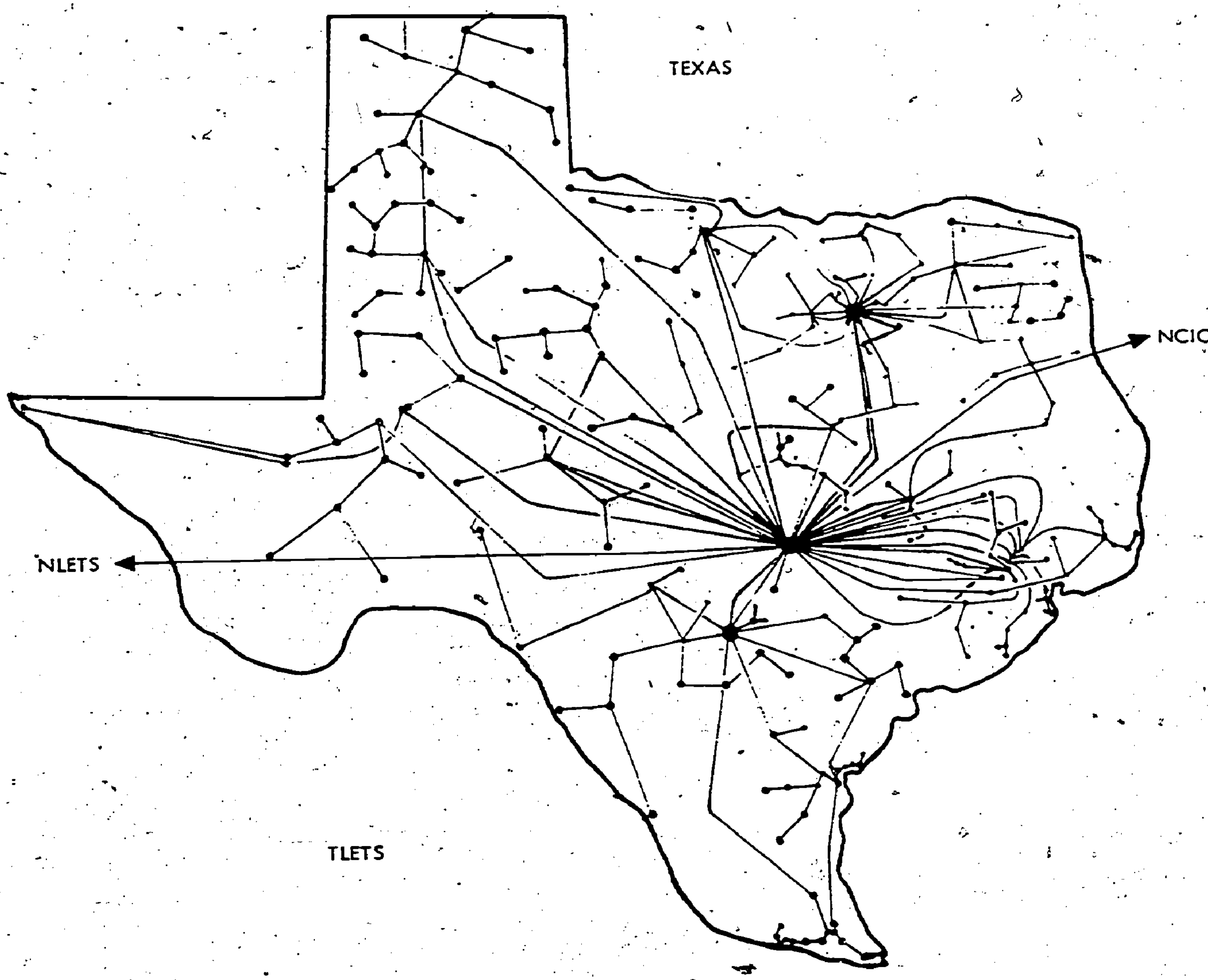


Figure 6-3. TLETS Circuit Configuration

The Texas Department of Public Safety prepares a report each quarter of the year that includes any changes to the TLETS system that occurred during the quarter. These reports were made available to us covering the period July 1971 through the present. We used them to compile information presented in Figure 6-4. Changes to user agencies served, circuits, data bases and switchers were recorded. This allowed us to identify past system changes that affected TLETS traffic levels.

Question 2

The second question was expanded to ask for information on the total number of system users, the average response time and the number of records in data files. Table 6-1 provided us with this information. Note the difference in response time between high-speed and low-speed line users. Also, most of the growth in the number of records in TCIC has been due to additions to the Computerized Criminal History file.

Question 3

Until the beginning of 1976, TLETS traffic statistics recorded only the number of messages sent and received by each circuit. Traffic volumes were not given by message types and, for circuits serving more than one agency, they did not record traffic to and from each agency. We did, however, use these circuits statistics to determine total TLETS traffic and the volume of traffic through switchers and into data bases. These statistics (an example month is shown in Figure 6-5) were available from October 1971 to December 1975.

A new management information statistics system was introduced in 1976. Figure 6-6 shows these statistics for one user agency for July 1976. The number of messages sent from user agencies into data bases and the number of responses received by the user agencies from data bases are shown. G-Codes are the general distribution messages and the category "other" includes administrative messages and messages into regional data bases. Average size represents message length in units of characters per message. However, currently, due to an error in software, message length calculations include only the "other" message types. This error is now being corrected. The daily distribution of messages is also given. Similar statistics pages exist for all user agencies and data bases. Statistics are grouped according to circuits and then by switchers. Aggregate statistics are given for each switcher.

Table 6-1. TLETS Past Data Bases and Number of Users

		1971	1972	1973	1974	1975	1976
Number of Users		135	268	310	319	419	436
High-Speed Circuits		0	2	7	7	23	28
Low-Speed Circuits		23	25	31	35	35	34
Average System Response Time		15 min	15 min	10 min	10 min	10 min	10 min
High-Speed Lines		0	0	15 sec	15 sec.	30 sec	30 sec
Low-Speed Lines		15 min	15 min	10 min	10 min	10 min	10 min
Number of Records in							
File Type 1	MVD	9.1 $\overline{M}$	9.6 $\overline{M}$	10.1 $\overline{M}$	10.7 $\overline{M}$	11.1 $\overline{M}$	11.7 $\overline{M}$
File Type 2	TCIC	0	0	392,244	691,249	1.2 $\overline{M}$	2.9 $\overline{M}$
-	NCIC	0	0	obtain from another source			
-	*LIDR	0	7.4 $\overline{M}$	7.7 $\overline{M}$	8 $\overline{M}$	8.3 $\overline{M}$	8.5 $\overline{M}$

*Our Drivers License file is currently growing at approximately 300,000 per year.

126

7/1/71-9/30/71

TERMINALS ADDED - 62 IN SEPT

TOT. TERM = 260 LS

CIRCUITS - 23 CIRCUITS INTO AUSTIN SWITCHER

DATA BASES -

2 75 bps LINES TO MVD - AUSTIN

SWITCHERS - AUSTIN ONLY

10/1/71-12/31/71

TERMINALS ADDED - PD TERRELL, U. S. CUSTOMS - HOUSTON, S.O. MARLIN, PD FOREST HILLS

TERMINALS DELETED - SO BAIRD, CENTRAL TEXAS COLLEGE, RANGERS WACO

TOTAL TERMINALS = 261 LS

CIRCUITS - NO CHANGE

DATA BASES - NO CHANGE

SWITCHERS - NO CHANGE

1/1/72-3/31/72

TERMINALS ADDED - BRYAN PD, COLLEGE STATION PD, CARDWELL PD, CENTERVILLE PD, NAVASOTA PD, HEARNE PD, EDNA SO, PERRYTOWN SO, FORT BLISS PMO, ARANSAS PASS PD, PORTLAND PD, NEW BOSTON PD, TAHOKA SO, LAREDO SO, STANTON SO

TOTAL TERMINALS - 276 LS

CIRCUITS - 85A1 CIRCUIT ADDED
PERMIAN BASIN CIRCUIT DIVIDED INTO TWO.
DPS NORTH CIRCUIT DIVIDED INTO TWO
25 LOW SPEED CIRCUITS
2 HIGH SPEED CIRCUITS

DATA BASES - INTERFACE TO NCIC COMPLETE
INTERFACE TO DRIVERS LICENSE RECORDS COMPLETE

SWITCHERS - NO CHANGE

OTHER - TELETYPE TRAINING MANUAL COMPLETE

10/1/72-12/31/72

TERMINALS ADDED - ANAHUAC SO, BAY CITY PD, BAY CITY SO, BELLVILLE SO, CLEVELAND PD, CONROE PD, CONROE SO, DANGERFIELD SO, HUNTSVILLE PD, JACKSONVILLE PD, LAKE WORTH PD, ORANGE SO, NACOGDOCHES SO, MOT VEH THEFT SEC, RICHLAND VALLEY PD, SPRING VALLEY PD, SPUR PD, STEPHENVILLE PD, VILLAGE PD, WAXAHACHIE PD, WHARTON SO

TERMINALS DELETED - STANTON S.O.

TOTAL TERMINALS - 304 LS

CIRCUITS

1 GTA6, 30GT5019, 30GT5020, (LOW SPEED)
30GD566, 30GD556, 1GT524 (HIGH SPEED)
27 LOW SPEED, 7 HIGH SPEED } AUSTIN
10 LOW SPEED, 3 HIGH SPEED } DALLAS

DATA BASES - NO CHANGE

SWITCHERS -

DALAS REGIONAL SWITCHER OPERATING 11-15-72

1/1/73-3/31/73

TERMINALS ADDED - STRATFORD S.O., KOUNTZEE S.O., MORTON S.O., CROWLEY PD, GONZALES S.O. ROSENBERG PD, SOUTHLAKE PD

TOT. TERM - 311
50 HS
261 LS

CIRCUITS
TCIC - 1-GTA9
CITY OF DALLAS COMPUTER - 30GD566
LOW SPEED 30GT548

28 LOW SPEED, 8 HIGH SPEED } AUSTIN
10 LOW SPEED, 4 HIGH SPEED } DALLAS

DATA BASES
TCIC BEGINS OPERATION
CITY OF DALLAS COMPUTER INTERFACE COMPLETED
DALLAS COUNTY COMPUTER
FORT WORTH CITY COMPUTER

SWITCHERS - NO CHANGE

4/1/73-6/30/73

TERMINALS ADDED - PIERCE DPS, EL PASO U. S. CUSTOMS, MADISONVILLE S.O., ALVIN PD, WOODWAY PD, MEREDIAN S.O., ODESSA S.O., EL PASO ORG. CRIME CTL., VEGA S.O., PARKS AND WILDLIFE

TOT. TERM - 321 { 50 HS, 271 LS

CIRCUITS - ADDED
1GTA14 - PARKS AND WILDLIFE AUSTIN
DISCONTINUED
30GT538
10GT202
30GD566

28 LS, 7 HS } AUSTIN
10 LS, 4 HS } DALLAS

DATA BASES - NO CHANGE

SWITCHERS - NO CHANGE

4/1/72 - 6/30/72

TERMINALS ADDED - FARWELL S.O., FREDERICKSBURG S.O., KERRVILLE PD, NEDERLAND MID-COUNTY DISPATCH CTR, BELLAIRE PD

TOTAL TERMINALS - 280 LS

CIRCUITS - NEW LOW SPEED CIRCUIT
26 LOW SPEED
2 HIGH SPEED

DATA BASES - NO CHANGE

SWITCHERS - NO CHANGE

7/1/72 - 9/30/72

TERMINALS ADDED - U. S. CUSTOMS - SAN ANTONIO, EAST TEXAS STATE SECURITY, PD COMMERCE (RO)

TOT. TERMINALS - 283 LS

CIRCUITS -
2 600 bps LINES TO MVD - AUSTIN
24 LOW SPEED
4 HIGH SPEED

DATA BASES -
TWO 600 bps LINES TO MVD - AUSTIN

SWITCHERS - NO CHANGE

7/1/73 - 9/30/73

TERMINALS ADDED - ALAMO HGTS PD, UNIVERSAL CITY PD, FLORESVILLE S.O., FLOYADADA S.O., CANADIAN S.O., SAN ANTONIO FBI, JEFFERSON S.O. HUNTSVILLE CORRECTIONS, ASPERMONT S.O., SINTON PD, JOURDANTON S.O., AIRPORT (DALLAS/FT WORTH), RAYMONDVILLE S.O., PHARR PD, SINTON S.O./INCOTERMS - FT WORTH S.O., FORT WORTH PD, ARLINGTON PD, GARLAND PD, MESQUITE PD, RICHARDSON PD

TERMINALS DELETED - PAINT ROCK S.O.

TERM. CONVERTED (TELETYPE → INCOTERM)
GRAND PRAIRIE PD, DALLAS PD, DALLAS S.O.

TOT. TERMINALS - 341 50 HS
291 LS

CIRCUITS
30GT550 SAN ANTONIO FBI - AUSTIN
30GD536 SAN ANTONIO SWIT. - AUSTIN

DELETED - 30 GT551, 30GT518, 30GT519, 30 GT537
25 LS, 8 HS } AUSTIN; 10 LS, 4 HS } DALLAS; 6 LS, 2 HS } SAN ANTONIO

DATA BASES - NO CHANGE

SWITCHERS -
INTERFACE TO SAN ANTONIO SWITCHER
(COMPLETED 8/28/73)

10/1/73 - 12/31/73

TERMINALS ADDED - BREHAM S.O., DALLAS FBI, LAKE JACKSON PD, W. UNIVERSITY PLACE PD, PARKS AND WILDLIFE-HOUS OLTON PD, CLUTE PD, WAXAHACHIC PD, CORSICANA S.O., VERNON PD, SHERMAN S.O., MARLIN PD, INGLESIDE PD/INCOTERMS - COLLEYVILLE PD, DALLAS-FT WORTH AIRPORT, DENTON S.O., DALLAS S.O. No. 2, RICHMOND S.O., ANAHUAC S.O., DUCANVILLE PD, DECATUR S.O., DALLAS PD No. 2, DALLAS PD No. 3, WEATHERFORD PD, DALLAS S.O. No. 3, PARIS S.O., FRISCO PD, UNIV. PK PD, WHITE SETTLEMENT PD, ROCKWALL PD, LIBERTY PD, SILSBEE PD/CONVERSION (TELETYPE → INCO) RICHLAND HILLS PD, EULESS PD, HALTOM CITY PD, FARMERS BRANCH PD, N. RICHLAND HILLS PD, HURST PD, CLEBURN PD, McKINNEY PD, IRVING PD, BEAUMONT PD, BEAUMONT S.O., NEDERLAND PD, DENTON PD, LEWISVILLE PD, STEPHENVILLE PD, PLANO PD, TEXARKANA S.O., GREENVILLE PD, WAXAHACHIE S.O., FOREST HILLS PD, SULFER SPRINGS PD, TERRELL PD, TEXARKANA PD, PARIS PD, KOUNTZE S.O., PORT ARTHER PD

DELETED
ARLINGTON PD, FT. WORTH S.O., RICHARDSON PD, MESQUITE PD, CLARKSVILLE PD, CARROLLTON PD

TOT. TERM - 368 63 HS
305 LS

CIRCUITS
1GTA15 DPS/AUSTIN
30GT553 PKS AND WILDLIFE - HOUSTON
26 LS, 9 HS } AUSTIN; 10 LS, 4 HS } DALLAS; 6 LS, 2 HS } SAN ANTONIO

DATA BASES - NO CHANGE

SWITCHERS - NO CHANGE

LS = LOW SPEED
HS = HIGH SPEED

Figure 6-4. Texas Past Improvements to Communication System

128

1/1/74-3/31/74

TERMINALS ADDED - SEABROOK PD, La PORTE PD, HEMPSTEAD S.O., ICR AUSTIN No. 2, COLUMBUS S.O., BONHAM PD, ENNIS PD/ (INCOTERMS) DESOTO PD, BURLESON PD, FORTWORTH/DALLAS TURNPIKE/CONVERSION (TELETYPE —INCO) ORANGE PD

TERMINALS DELETED - GARLAND PD

TOT. TERM = 377 63 HS
314 LS

CIRCUIT
1GT816
1GDA134

DELETED - 30GT543, 30GD575
30 LS, 11 HS } AUSTIN · 2 LS, 11 HS } DALLAS · 6 LS, 3 HS } SAN ANTONIO

DATA BASES
NLETS - COMPUTER-TO-COMPUTER INTERFACE
CITY OF HOUSTON COMPUTER

SWITCHERS - NO CHANGE

4/1/74-6/30/74

TERMINALS ADDED - S. HOUSTON PD, LANCASTER PD, ADDISON PD, DONNA PD, FRIENDWOOD PD, TOMBALL PD, EL PASO FBI, MERCEDES PD, HILDAGO PD

TERMINALS DELETED - FORT WORTH PD, FORT WORTH PD, (RO), VAN HORN S.O.

TOT. TERM. - 383 63 HS
320 LS

CIRCUITS - 30GD575
31 LS, 11 HS } AUSTIN · 2 LS, 11 HS } DALLAS · 6 LS, 3 HS } SAN ANTONIO

DATA BASES
SAN ANTONIO COMP?

SWITCHERS - DALLAS SWITCHER MOVED TO DPS REGIONAL HEADQUARTERS (MAY 31, 1974)

4/1/75-6/30/75

TERMINALS ADDED - EASTLAND PD, INGLESIDE PD, KATY PD, HUMBLE PD, HOUSTON S.O. WARRANT SERVICE, GEORGE WEST S.O., GILMER S.O., ROBY S.O.

DELETED - DPS TURNPIKE, CISCO PD, LAKE CHARLES, LOUISIANA S.O.

TOT. TERM. - 403 63 HS
340 LS

CIRCUITS - NO CHANGE

DATA BASES
WICHITA FALLS REG. DATA BASE - OPERATIONAL

SWITCHERS -
NO CHANGE

7/1/75-9/30/75

TERMINALS ADDED - THP FORT WORTH DIS. OFFICE, HITCHCOCK PD, SPEARMAN PD, DALLAS IRS REG. OFFICE, DPS - AUSTIN RADIO RM, (CONV. L.S. —HS) DPS-AUSTIN COMM. CTR., DPS-AUSTIN I.C.R., DPS BRYAN, DPS WACO, DPS DAL/GAR., DPS-TYLER, DPS WICHITA FALLS, DPS AMARILLO, DPS LUBBOCK, DPS ABILINE, DPS-MIDLAND, DPS EL PASO, DPS SAN ANGELO, DPS OZONA, DPS SAN ANTONIO, DPS CORPUS CHRISTIE, DPS HARLINGEN, DPS HOUSTON, DPS BEAUMONT

TOT. TERM - 409 81 HS
328 LS

CIRCUITS - 1200 bps
1GD4072 (A-24), 1GD4073(A-25), 1GD4074(A-40), 30GD621(A-41), 30GD628(A-42) 30GD623(A-43), 30GD624(A-44), 30GD625(A-45), 10GD(D-18), 10GD70(D-19),

110 bps
30GT557(A-27), 30GT558(A-28)
30GT559(A-29) FORM. GT5020, 30GT560(A-30) FORM. GT5019

2400 bps
20FD81(A-34) HARRIS COUN COMP; 30GD637(A-36)
DALLAS SWIT.; 10FD361(D-26)

75 bps
10GT215(D-2), 10GT216(D-3), 10GT217(D-4)

1200 bps
1GD529(A-37); 1GD528(A-38) (BOTH UPGRADED - 600 bps)

DELETED - 1GTA009, 1GTA016, 30GT532

DATA BASES - MVD LINES UPGRADED 600-1200 bps

SWITCHER -
1) A-SWIT's NOVA 1200 REPLACES NOVA 800.
2) 2nd LINE BETWEEN AUSTIN-DALLAS/GARLAND SWIT
3) 10 1200 bps LINE INTERFACES ON A-SWIT. AND 3 ON DALLAS/GARLAND SWIT. TO ACCOM 20 DATA SPEED 40 TERMS.
4) 23 TELETYPE TERM. TRANS FROM A-SWIT. TO DALLAS/GARLAND SWIT.
5) SECOND MICRO INTERFACE INSTALLED IN A-SWIT FOR TCIC

6-9

7/1/74-9/30/74 TERMINALS ADDED - HOUSTON FBI, CLIFTON PD, BOERNE S.O., KARNES CITY S.O., JERSEY VILLAGE PD, ANGLETON PD, EL PASO DRUG ENF. AGN, AUSTIN DPS - SAFETY RESP, GROSBECK PD DELETED - NEW BOSTON PD, ORGAN. CRIME CTL. UNIT - EL PASO TOT. TERM. - 390 63 HS 327 LS CIRCUITS - NO CHANGE DATA BASES - NO CHANGE SWITCHERS - CORE SIZE OF AUSTIN SWITCHER EXPANDED FROM 32K TO 62K. ALLOWS FORMAT MASKING OR CALL UP ON ALL TYPES OF INQUIRY FORMATS TO DATA BASES	10/1/74-12/31/74 TERMINALS ADDED - FORT SAM HOUSTON PMO, CRYSTAL CITY PD, GOLIAD S.O., TOT. TERM - 393 63 HS 330 LS CIRCUITS - NO CHANGE DATA BASES - NO CHANGE SWITCHERS - NO CHANGE	1/1/75-3/31/75 TERMINALS ADDED - SAN DIEGO S.O., WEBSTER PD, LEAGUE CITY PD, SMU SECURITY POLICE, NOLANVILLE PD TOTAL TERMINALS - 398 63 HS 335 LS CIRCUITS - 30 LS 11 HS AUSTIN 8 LS 11 HS DALLAS 6 LS 3 HS SAN ANTONIO DATA BASES - TARRANT COUNTY REG. DATA BASE BEGINS OPERATIONS. WICHITA FALLS REG. DATA BASE - BEGINS OPERATIONS BUT LOW TRAFFIC VOLUME DUE TO PROBLEMS. HARRIS COUNTY COMPUTER SWITCHERS - SIX NEW REGIONAL INTERSTATE HIGHWAY GROUP CODES AVAIL. FOR ALL TELETYPE USERS. NEW GENERAL WANTED PERSONS SUMMARY NOW IN EFFECT
10/1/75-12/31/75 TERMINAL ADDED - SOUTHSIDE PLACE PD (LS), HIGHLAND PARK PD (HS), NATB DALLAS (HS) DELETED - SUNDOWN PD, MASON S.O. TOT. TERM. - 410 83 HS 327 LS CIRCUITS - ADDED 10GD603 DALLAS/GARLAND 1200 bps DATA BASES - NO CHANGE SWITCHER - NO CHANGE	1/1/76-3/31/76 TERMINALS ADDED - LOW SPEED LEON VALLEY PD, ROCKPORT S.O., CONVERSION HIGH SPEED (ICC 40+) DPS DALLAS/GARLAND, DPS SURPHUR SPRINGS, DPS SHERMAN, DPS TEXARKANA, DPS CHILDRESS, DPS MINERAL WELLS, DPS AUSTIN NARCOTICS SVC., DPS AUSTIN ICR No.2, DPS PIERCE, DPS PECOS, DPS LAMPASAS, DPS LUFKIN, DPS VICTORIA, DPS KERRVILLE, DPS DEL RIO TOT. TERM. - 412 98 HS 314 LS CIRCUITS 30GD674 AUSTIN 1200 bps 1GD4137 AUSTIN 1200 bps 1GD4135 AUSTIN 2400 bps DATA BASE - SECOND 2400 bps LINE TO TCIC LIDR LINES UPGRADED - 600 bps - 1200 bps CITY OF AUSTIN SWITCHER - NO CHANGE	4/1/76-6/30/76 TERMINALS ADDED - LOW SPEED GALENA PK PD, HARRIS COUNTY OCU, LIBERTY S.O., JACINTO CITY PD, HUNTSVILLE S.O., GATESVILLE PD, HARKER HGTS PD, LAMPASAS S.O., WINNSBORO PD, SOUTHLAKE PD, GRAPEVINE PD, BEDFORD PD HIGH SPEED - DEA - DALLAS DELETED - EL DOREDO S.O., STERLING CITY S.O., SPEARMAN PD TOT. TERM. - 421 105 HS 316 LS CIRCUITS DELETED (ALL BEEN CONV. TO HSL) 30GT545 30GT526 1GT509 DATA BASE - NO CHANGE SWITCHER - NO CHANGE LEGEND: LS = LOW SPEED HS = HIGH SPEED

Figure 6-4. Texas Past Improvements to Communication System (Continuation 1)

Date ______________ Period 12-01-75 to 12-31-75

LINE	CKT	MREC	MSEN	MMON	TOTAL
00	1GT507	1261	546	0	1807
01	30GT526	5063	3405	0	8468
02	30GT527	7397	5895	0	13292
03	30GT553	4707	2325	0	7032
04	1GT506	20243	26	0	20269
05	1GT508	3363	0	0	3363
06	1GTA15	76	17736	0	17812
07	30GT545	12468	8835	0	21303
08	30GT548	23904	19511	0	43415
09	30GT516	17255	13885	0	31140
10	1GTA16	0	0	0	0
11		0	0	0	0
12	30GT520	9406	7080	0	16486
13	30GT521	10103	8022	0	18125
14	1GTA6	6159	2650	0	8809
15	1GTA9	0	0	0	0
16	1GT509	376	1206	0	1582
17	30GT523	14676	12326	0	27002
18	30GT524	22269	17769	0	40038
19	30GT534	14756	11955	0	26711
20	30GT535	20106	15977	0	36083
21	30GT533	12844	9334	0	22178
22	30GT550	1944	906	0	2850
23	30GT540	24531	17995	0	42526
24	1GD4072	7652	5971	0	13623
25	1GD4073	7126	3778	0	10904
26	30GD579	32858	25549	0	58407

Figure 6-5. TLETS Circuit Traffic Statistics

Date ______ Period 12-01-75 to 12-31-75

LINE	CKT	MREC	MSEN	MMON	TOTAL
27	30GT557	17664	14347	0	32011
28	30GT558	13394	10211	0	23605
29	30GT559	20996	16134	0	37130
30	30GT560	14619	10334	0	24953
31	30GT539	8165	6294	0	14459
32	1GDA134	107521	108131	0	215652
33		0	0	0	0
34	20FD-00S1	10199	7446	0	17645
35	30GD556	239953	205246	0	445199
36	30GD637	280869	214958	0	495827
37	1GD528	150121	150053	0	300174
38	1GD529	155540	155523	0	311063
39	30GD536	142735	120421	0	263156
40	1GD4074	12145	7154	0	19299
41	30GD621	5855	4144	0	9999
42	30GD622	5959	3937	0	9896
43	30GD628	13421	9431	0	22852
44	30GD623	26245	18081	0	44326
45	30GD624	0	0	0	0
46	30GD625	12973	9471	0	22444
47		0	0	0	0
48	30GD559	64037	50651	0	114688
49	1GDA5	420921	421170	0	842091
50	GFC5021	165384	183729	0	349113
51	FDA90622 015	33005	33182	0	66187
52	(TCIC)	0	0	0	0
56	-MTL	-141566	0	0	-141566
TOTAL		2,202,264	1,972,730	0	4,174,994

Figure 6-5. TLETS Circuit Traffic Statistics (Continuation 1)

TLETS USER MANAGEMENT REPORT
MESSAGES SENT AND RECEIVED BY
- AZJF -
EL PASO PD

	LIDR	TCIC	NCIC	MVD	NLETS	STA ERR	G-CODES	OTHER	AV. SIZE	TOTAL	DAILY AVG
SENT	120	1283	0	778	302	180	1	99	320	2763	89
RECEIVED	112	1247	1065	766	351	180	909	210	414	4840	156
TOTAL	232	2530	1065	1544	653	360	910	309	384	7603	245

* *

TOTAL MESSAGE TRAFFIC AVERAGED BY HOUR AND DAY

TIME INTERVAL	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	HOURLY AV	MONTHLY TOTAL
0000-0100	7	5	9	10	2	6	14	7	240
0100-0200	8	4	7	11	11	3	9	7	247
0200-0300	9	18	3	16	7	1	8	9	282
0300-0400	7	17	7	7	3	4	9	7	239
0400-0500	19	14	13	8	4	2	20	11	359
0500-0600	6	10	7	23	3	3	13	9	289
0600-0700	8	6	13	18	9	8	6	10	311
0700-0800	5	1	5	5	21	12	11	9	292
0800-0900	2	3	8	4	23	23	2	10	319
0900-1000	6	10	8	10	10	18	7	10	322
1000-1100	5	12	17	11	7	12	9	10	339
1100-1200	10	15	12	11	8	9	8	10	324
1200-1300	5	22	13	18	15	11	6	13	403
1300-1400	9	13	9	7	15	8	9	10	322
1400-1500	10	11	17	10	11	9	9	11	341
1500-1600	11	28	18	13	9	4	8	12	393
1600-1700	10	22	18	7	6	8	15	12	383
1700-1800	15	7	24	22	6	7	11	13	404
1800-1900	13	18	26	20	4	5	9	13	411
1900-2000	18	6	18	8	5	6	9	10	317
2000-2100	8	6	15	16	2	4	5	7	245
2100-2200	9	6	9	12	12	3	12	9	293
2200-2300	13	8	9	8	10	5	6	8	271
2300-0000	12	4	13	16	4	4	4	8	252
DAILY AVERAGES	230	276	306	300	216	184	229	245	7603

* *

STATION ERRORS

ILLEGAL ADDRESS	12	TAPE HUNG	0	INVALID PRIORITY	0
MISSING EOM	55	TOO MANY ADDRESSES	0	INCORRECT FORMAT	0
NO TEXT IN MESSAGE	0	MORE THAN 3 G-CODES	0	OTHER	113

Figure 6-6. TLETS Traffic Statistics.

Question 4

The TCIC manual and example drivers license and vehicle registration formats were used to determine average message length. Table 6-2 shows the average message length results. Combining these message lengths with the distribution of traffic by message type allows us to calculate an overall average message length of 110 characters per message.

Question 5

No information available.

Question 6

Messages are automatically forwarded from the Austin switcher to the NCIC data base in Washington, D.C.

Question 7

Three planned upgrades mentioned were:

(1) A substantial increase in the number of Computerized Criminal History records

(2) The expected upgrade of about 300 low speed terminals (75 bps) to high-speed CRT terminals (1200 bps)

(3) A 20% increase of new users.

Table 6-2. Texas Average Message Lengths (Characters per Message)

Message Type	In	Out
TCIC	48	86
LIDR	35	300
MVD	50	175
Adm	500	500
NLETS-Adm	370	250
NLETS-Data Base	100	290
NCIC	50	90

USER SURVEY

Approximately 270 of the TLETS user agencies responded to our user surveys. Results from these responses are now presented.

Traffic Statistics

Traffic statistics obtained from user agencies agreed well with traffic statistics provided by the state. One statistic of interest obtained from the user survey was a measure of the peak-to-average traffic ratio at each terminal. The average peak-to-average ratio over all reporting terminals was 2.33 and the ratio ranged from 8 to close to 1.25.

Response Time

Acceptable response times were of interest to us because of the impact response time has on system design. Figure 6-7 shows the results of the responses by user agencies in the acceptable response time question. Figure 6-7 is a frequency diagram showing the number of responses falling within acceptable response time ranges. For example, 18 agencies indicated an acceptable average response time of 10 sec or less. The two most frequently chosen times were 30 and 60 sec. The range was from 2 sec all the way to 300 sec with the mean being 52 sec. Most agencies reported the acceptable response time to be very close to the existing response time.

User Agency Characteristics

Because not all user agencies returned their surveys, other sources were identified to obtain population, personnel and crime rate statistics. The primary source of data was a listing of uniform crime reports by county (Figure 6-8). Each county is broken out by incorporated and unincorporated areas and statistics are presented on population and the FBI's seven index crimes. An example, shown in Figure 6-8, is Cameron County. There are five cities in Cameron County: Brownsville, Harlingen, San Benito, La Feria and Port Isabel. The population and number of index crimes occurring in each of these cities is presented as well as totals for the incorporated areas. The next line shows population and incidence of crime for the unincorporated area of the County. The unincorporated areas are served by the Sheriff Departments. Finally the total County population and incidence of crime statistics are presented. These statistics were available for all counties in Texas.

Additional personnel data were obtained from the uniform crime reports issued annually by the FBI entitled Crime in the United States. Under the Police Employee Data section, tables are included showing the number of full-time police department employees in cities 25,000 and over in population and in cities 25,000 and under in population.

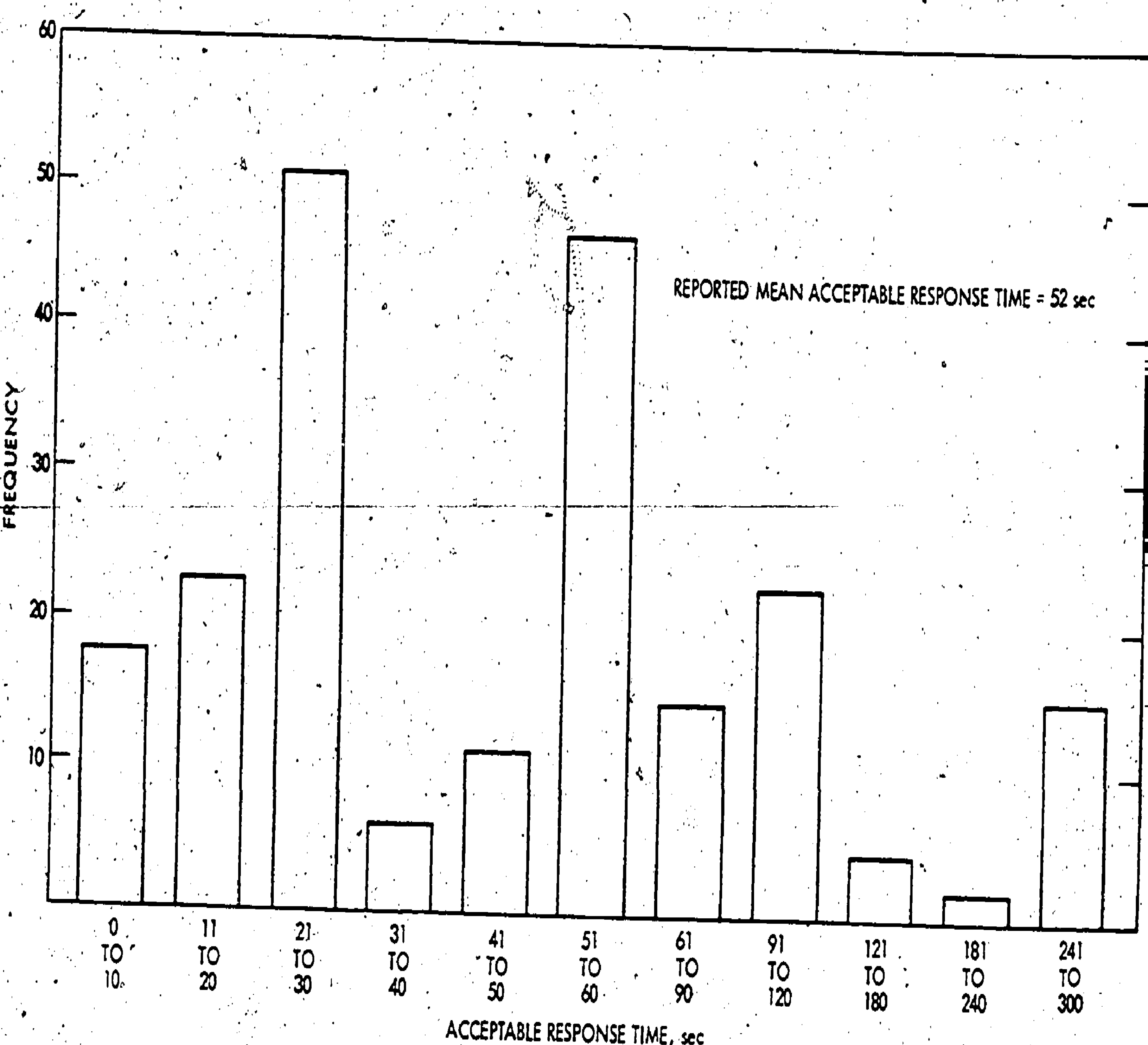


Figure 6-7. Acceptable Response Time

CITY		POP	INDEX	MURD	MANS	RAPE	ROBB	ASSLT	BURG	LARC	AUTOS
BURNET		12,929	170	1		1	3	10	12	75	10
	COUNTY TOTAL	15,337	239	2		3	6	15	96	105	12
	RATE PER	100,000	1,509.1	12.6		13.9	37.9	94.7	603.2	663.0	75.8
LOCKHART		6,587	94	1			2	1	58	52	
LULING		4,791	165				1	9	55	94	6
CALDWELL		11,463	150	1		1	2	9	64	64	9
	COUNTY TOTAL	22,341	409	2		1	5	19	157	210	15
	RATE PER	100,000	1,790.8	8.8		4.4	21.9	83.2	637.4	919.4	65.7
PORT LAVACA		12,918	553	2		2	5	5	156	372	11
CALHOUN		5,350	218					4	74	129	11
	COUNTY TOTAL	13,753	771	2		2	5	9	250	351	22
	RATE PER	100,000	4,108.1	10.7		10.7	26.6	48.0	1,225.5	2,665.8	117.2
CALLAHAN		9,035	23				1	1	14	7	
	COUNTY TOTAL	9,035	23				1	1	14	7	
	RATE PER	100,000	254.0				11.1	11.1	155.0	77.5	
BROWNSVILLE		70,963	2,968	3	1		11	41	991	1,890	232
HARLINGEN		40,000	2,035	2	1		11	118	471	1,351	104
SAN BENITO		17,618	442					23	92	297	36
	TOTAL	128,561	5,445	5	2		22	180	1,554	3,318	365
LA FERIA		3,544	2					1	1		
PORT ISABEL		4,200	8					1	1	6	
	TOTAL	7,744	10					2	2	5	
CAMERON		34,529	233	10	1	11	15	38	35	56	12
	COUNTY TOTAL	170,654	5,658	15	3	11	37	220	1,341	3,550	358
	RATE PER	100,000	3,329.2	0.8	1.8	6.4	21.7	128.6	960.5	1,978.3	724.8

6-17

77-53, Vol. III

Figure 6-8. Texas Uniform Crime Reports

6.1.2 Analysis Methodology Applied to Traffic Statistics

Two different types of statistics were used in Texas to determine total system traffic. First, recall that prior to 1976, only message volumes by circuit were available. These circuit statistics provided information on the number of communication messages sent and received by each circuit. Since each communication message is sent and received, these statistics double counted communication messages.

After 1976, the number of messages was broken out by user agency and message type (Figure 6-6). Different message types were counted as follows:

(1) Messages into Texas State Data Bases - TCIC, MVD, LIDS

Each user agency sending a message into these data bases has one message recorded in the sent row and when the response returns has one message recorded in the receive row. In addition, each of the data bases has a message recorded in the receive row when it receives a message from a user agency and a message recorded in the send row when it responds. This leads to double counting of these data base messages.

(2) Messages into NCIC

Each time a response is received from NCIC a message is recorded as being received by a user agency and sent by the NCIC computer. There is no double counting of NCIC messages.

(3) Messages into NLETS

All messages sent by user agencies or computers into NLETS are recorded as being sent by the agency and received by NLETS while messages sent by NLETS are recorded as being sent by NLETS and received by a user agency. NLETS messages are double counted.

(4) G-Code messages

When an agency wants to send a message to many or all other agencies, the message travels to the appropriate DPS terminal (Austin, Garland/Dallas, or San Antonio). The message is recorded as being sent by the agency and also being sent by the DPS send terminal. Each message sent by the DPS send terminal is received by many user agencies and each of these receiving terminals records a message being received. Thus, send messages are double counted but receive messages are not.

(5) Other messages

These are administrative messages from one user agency to another. Each other message is recorded as being sent by one agency and received by another. Thus, there is double counting of these messages.

A set of these user agency statistics is given for all users, data bases, and switchers directly connected to the Austin switcher and for all users and switchers directly connected to the Dallas switcher. The third switcher, located in San Antonio, is not operated by the Department of Public Safety and thus does not have similar detailed traffic statistics. However, looking at the set of Austin switcher statistics, the Dallas switcher and the San Antonio switcher are included as user agencies. Thus all traffic coming from terminals tied directly into the Dallas or San Antonio switcher into the Austin switcher is included in the set of Austin switcher statistics. This includes all messages into Texas state data bases, messages into NCIC and NLETS, and a fraction of the G-Code messages. Those messages not included are the intra-switcher messages of the Dallas and San Antonio switchers. These include administrative messages between Dallas users or San Antonio users, queries by Dallas users into the Dallas regional data bases, and G-Code messages between one Dallas user and only other Dallas users and between one San Antonio user and only other San Antonio users. Since statistics were available from the Dallas switcher, these intra-switcher message columns were available for Dallas. San Antonio intra-circuit statistics were obtained from the San Antonio Police Department. Figure 6-9 shows the flow of messages over the TLETS system in June 1976. Message flows shown with solid arrows are to and from data bases while dashed arrows signify G-Code or administrative messages. All data base messages are into state or national files except for 1,200 messages from Dallas terminals into the regional Dallas data bases and 3,900 responses from the regional data bases back to Dallas terminals. Terminals shown to the right of the Dallas data base and San Antonio data base are part of regional or local systems. The terminals and communication lines serving these agencies are not part of the state TLETS system. However, traffic from these terminals is reformatted by regional computers and sent into the state system.

Administrative traffic is shown between Dallas Terminals and other Dallas Terminals, between Austin Terminals and other Austin Terminals, between San Antonio Terminals and other San Antonio Terminals, between Dallas Terminals and Austin Terminals and between San Antonio Terminals and Austin Terminals. We show that there are many more G-Code messages from switchers to users than from users to switchers.

Using the above interpretations of the Texas traffic statistics we were able to establish past traffic growth patterns from 1971 to the present, which was used to establish Texas baseline growth.

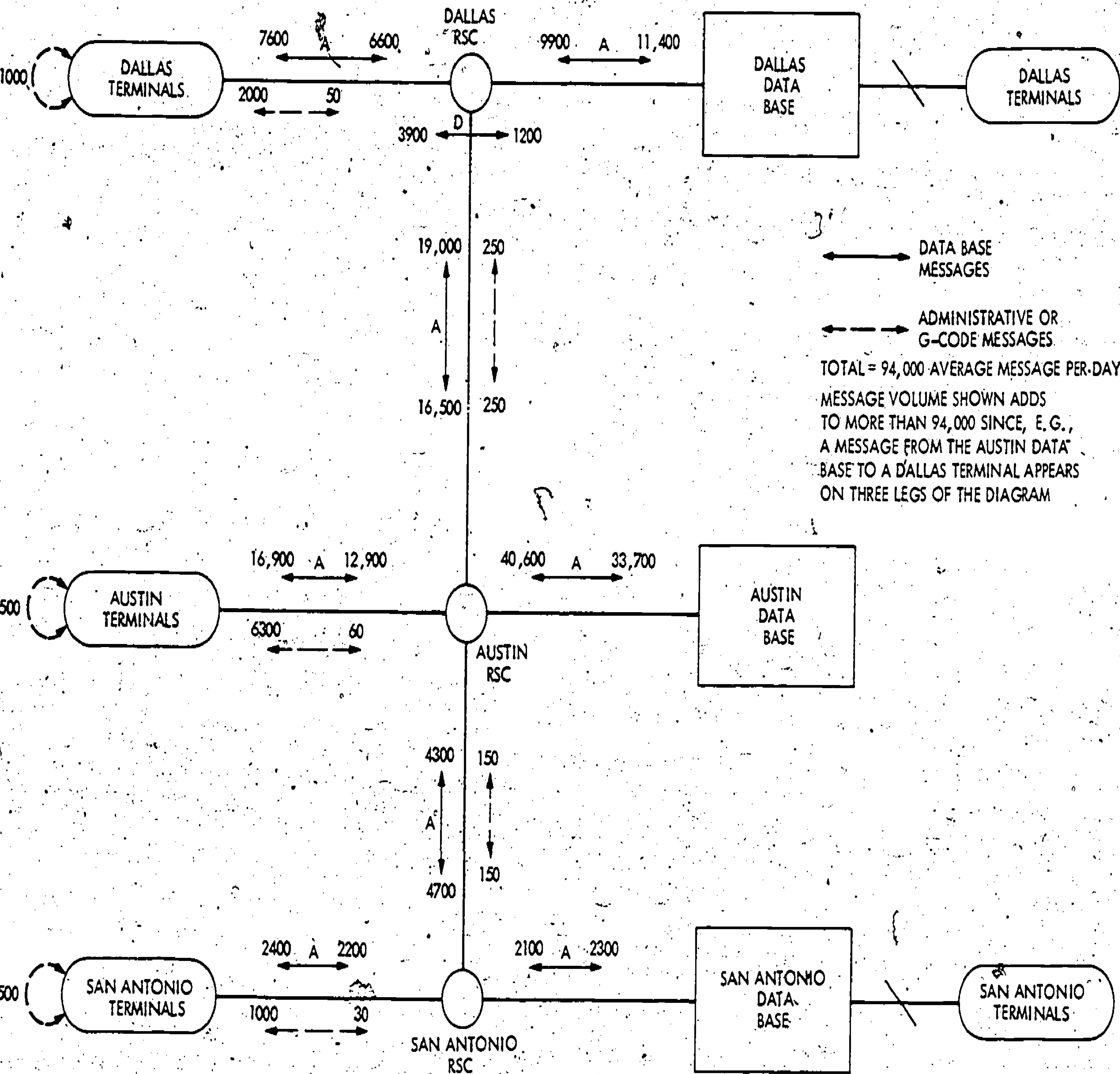


Figure 6-9. TLETS Message Flow, June 1976, Average Messages per Day

6.1.3 Peak/Average Traffic Ratio

Recall that the peak-to-average ratio is the ratio of traffic volumes during the peak hour and average traffic volumes. We use the computer's peak/average ratio to describe traffic variations of the entire system (see Section 3.3.4).

In Texas one average peak/average ratio was used for all state data bases. Traffic into state data bases was 4,522 messages per hour during the busiest hour of July 1976 and averaged 2,565 messages per hour in the same month. The peak/average ratio is

$$\frac{4,522}{2,565} = 1.76$$

To insure that we would not underestimate traffic, a peak-to-average value of two was used in Texas.

6.1.4 Traffic Growth Modeling

6.1.4.1 Past Traffic Growth. After interpreting the Texas traffic statistics we were able to construct the curve of past growth in communication messages which is shown in Figure 6-10. The curve shows a pattern of continuing growth.

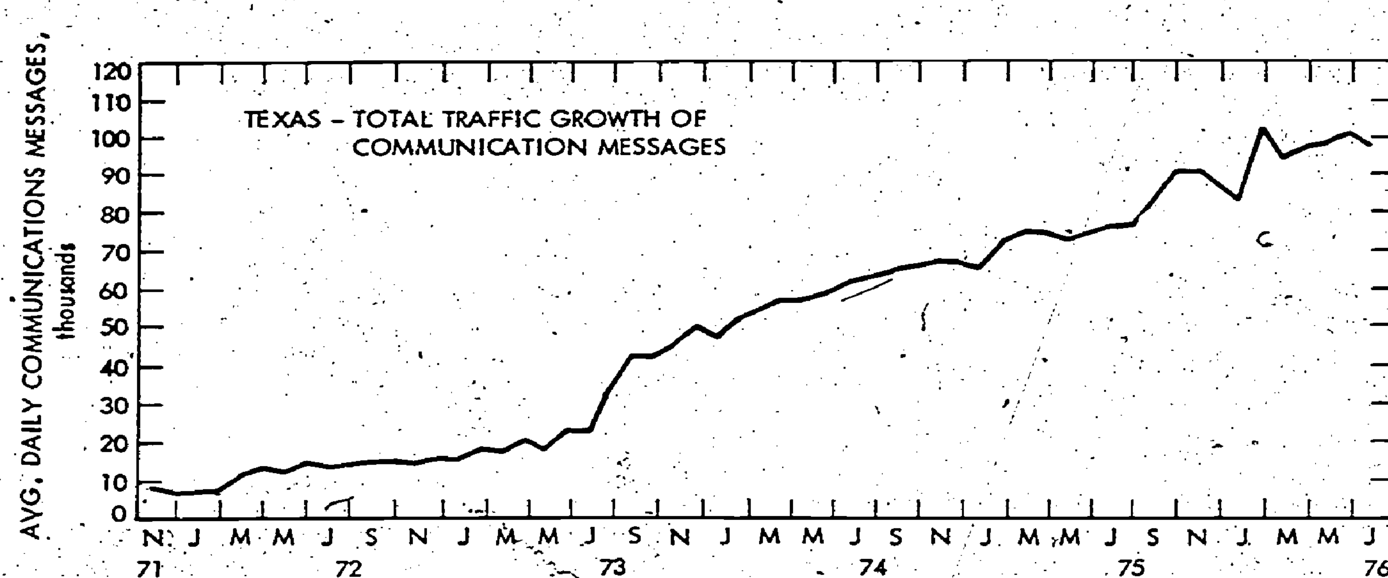


Figure 6-10. Texas Past Communications Traffic Growth

143

The sharp increase in traffic that occurred between April and July of 1973 was caused by the addition of the TCIC data base. In our analysis of past growth we only go back as far as 1973. Our justification is that prior to 1973 the TLETS system was so much different than in later years that comparisons would be inappropriate.

6.1.4.2 System Improvements. A portion of past traffic growth can be related directly to system improvements. Past improvements were:

(1) Addition of new system users.

(2) Addition of new data files

(3) Substitution of low-speed communication lines with high-speed lines and new terminal equipment.

(4) Implementation of local and regional information systems.

Between January 1, 1973, and the present, there have been 106 new agencies joining the TLETS system.

Table 6-3 shows the increases in traffic caused by the addition of new terminals which are all serving law enforcement agencies. The fact that significant traffic increases were occurring in 1976 due to new agencies suggests that not all potential law enforcement agencies are subscribers to the TLETS system.

There were three periods in Texas when lines were upgraded from low speed to high speed. The first occurred in October 1973 when 60 agencies were provided with high-speed service. The benefitting agencies were Police Departments and Sheriff Offices, and the estimated resultant traffic increase was 3,700 messages per day. The second upgrade began in July 1975. Twenty Department of Public Safety Offices were provided with high-speed lines leading to an increase in traffic of 3,900 messages per day. Finally in January 1976, 15 additional Department of Public Safety Offices were given high-speed lines. The accompanying traffic increase was 2,550 messages per day.

The addition of the TCIC data base in July 1973 had a major impact on traffic which was discussed in Section 3.4.3.1.

Finally, the implementation of local and regional systems caused an increase in traffic. Small increases in traffic were identified from the city of Houston, Harris County, Wichita Falls and Tarrant County. All together these increases totaled 1,650 messages/day.

Table 6-3. Texas New Agency Traffic Impact

Time Period	Total Traffic Increase
January 73 - February 74	5022
February 74 - February 75	2023
February 75 - Present	4081
Total	11,126

Table 6-4 summarizes the effects on traffic of improvements to the communication system. The impact during each 3-month period caused by all system improvements is shown in the right-hand column. Note that the largest increase occurs in late 1973 because of the addition of the TCIC data base. Substantial increases are also indicated in the third quarter of 1975 and the first quarter of 1976 due to the conversion of low-speed lines to high-speed lines.

To obtain baseline growth we subtract out all past traffic increases caused by system improvements. Figure 6-11 shows graphically this subtraction process. The top line represents total TLETS traffic averaged over 3-month periods. The next line down is TLETS traffic with increases due to the addition of new terminals subtracted out. Successive lower lines represent the subtracting out of traffic caused by implementation of regional systems, the addition of the TCIC data base and high-speed lines.

6.1.4.3 Traffic Projections. The baseline growth curve developed in the previous section is used to project future baseline traffic. We have shown that, in the past, baseline growth displayed an S-shaped curve with growth being slow before and after system upgrades and linear between these periods. In order to predict future traffic growth we must make assumptions regarding actions to be taken by Texas decision makers in upgrading communication capacity. Conversations with Texas planners led us to the assumption that it is not likely that the state will increase capacity before saturation effects begin to occur. However, once these effects become evident, funding necessary for increasing capacity will be obtained rapidly.

Table 6-4. Texas Impacts of System Improvements - Average Messages/Day

	New Terminals	High-Speed Lines	Data Bases	Regional Data Bases	Total
January-March, 1973	817	0	0	0	817
April-June, 1973	1,041	0	0	0	1,041
July-September, 1973	1,764	0	13,500	1,000	16,264
October-December, 1973	1,400	3,718	4,000	0	9,118
January-March, 1974	496	0	900	0	1,396
April-June, 1974	623	0	0	1,500	2,123
July-September, 1974	700	0	0	0	700
October-December, 1974	204	0	0	0	204
January-March, 1975	492	0	0	650	1,142
April-June, 1975	526	0	0	0	526
July-September, 1975	821	3,920	1,000	0	5,741
October-December, 1975	1,067	0	0	0	1,067
January-March, 1976	130	2,549	1,300	0	3,979
April-June, 1976	1,045	0	0	0	1,045
	11,126	10,187	20,700	3,150	45,163

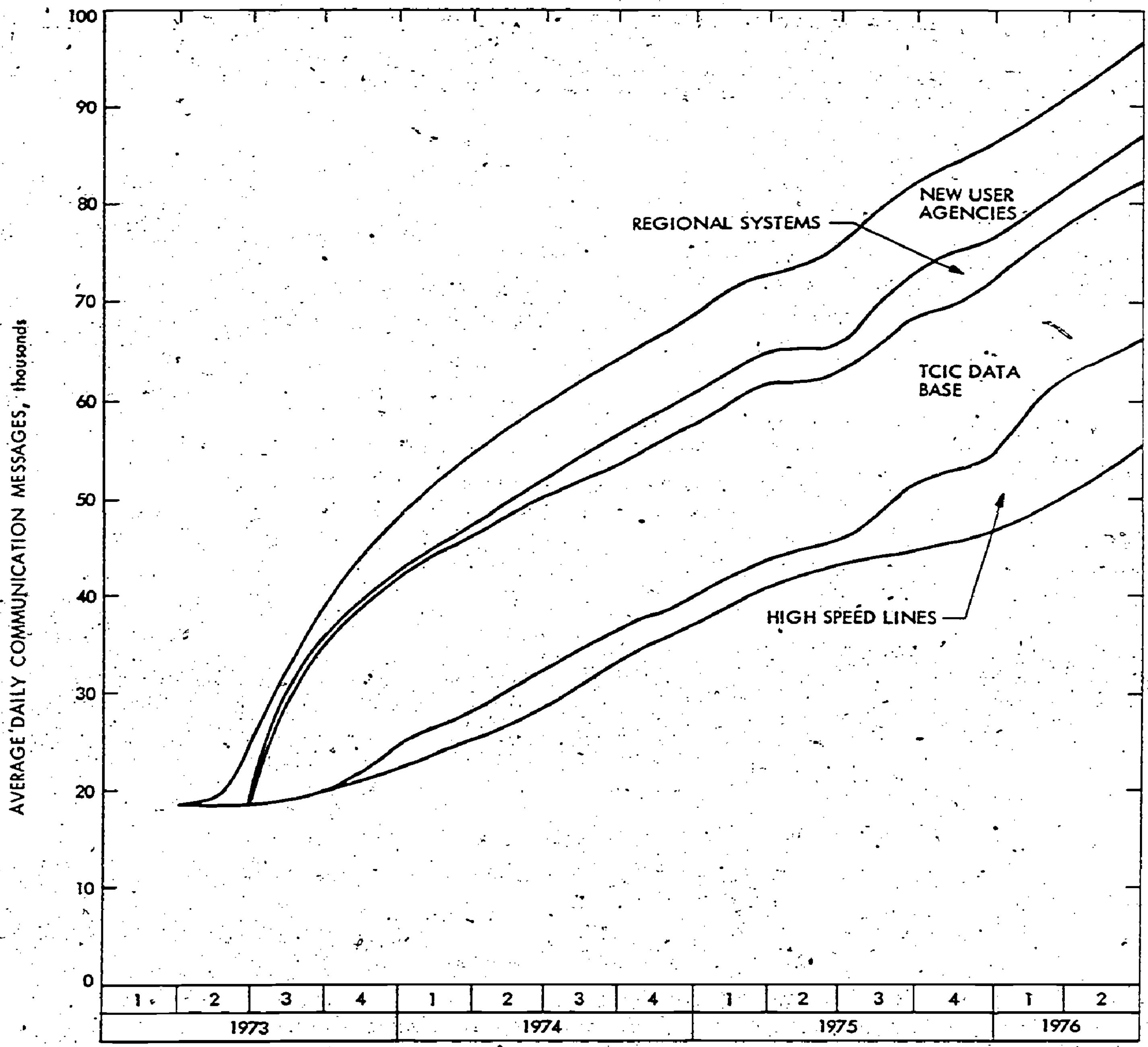


Figure 6-11. Total Growth and Baseline Growth

Texas baseline growth displays less of an S-shaped curve than other states because of the distributed nature of the TLETS system (see Section 3.4.4). However, we can identify periods of constrained and unconstrained growth. Figure 6-12 shows the Texas baseline growth data points. Lines are fit to the data points of the unconstrained growth period of January 1974 through March 1975 and the slow growth period of April 1975 through December 1975. The slow growth period line has a slope of 2,120 messages/3-month period which is interpreted as an increase of 2,100 messages per day each 3-month period. When projecting traffic growth after an upgrade, we will assume an increase of 4,200 messages per day during the 6-month period after the upgrade.

The "best fit" regression line during the unconstrained growth period has a slope of 3,840 messages/3-month period. Thus during periods of unconstrained growth we will project average daily traffic increases of 7,700 messages per day each 6-month period.

Using these linear expressions we can project baseline traffic between January and June of 1976. The line drawn in Figure 6-12 during this time period represents the projection. Notice that we project a traffic level of 54,980 messages per day during April-June 1976 while the actual value is 54,600 messages per day.

In addition to increases in traffic volumes caused by baseline growth, there will be increases caused by communication system improvements. In Texas, five areas of improvement were identified: addition of new users, conversion to high-speed lines, regional information systems, mobile digital terminals, and NCIC access.

Texas plans to offer a high-speed link to any law enforcement agency in the state within the next year. The agency must pay for the communication terminal however the state will pay for the communication line. The state expects all current system users to remain users and they also expect many new agencies to join. We assumed that any law enforcement agency currently without a TLETS terminal and which serves a population of 5,000 or more people will join. There are 133 such agencies in Texas. A user characteristic data base was constructed for these 133 agencies containing information on population served, number of personnel, crime rate, and agency type. The expressions shown for Texas in Table 3-7 were then used to estimate traffic from these potential new users. We projected 7,300 messages per day from the new system users.

The conversion to all high-speed lines is expected to be completed by late 1977. In the past, when agencies in Texas have been provided with high-speed lines, a 50% increase in traffic was observed. Assuming this rate of increase continues in the future, an increase of 31,300 messages per day will be caused by the high-speed line upgrade.

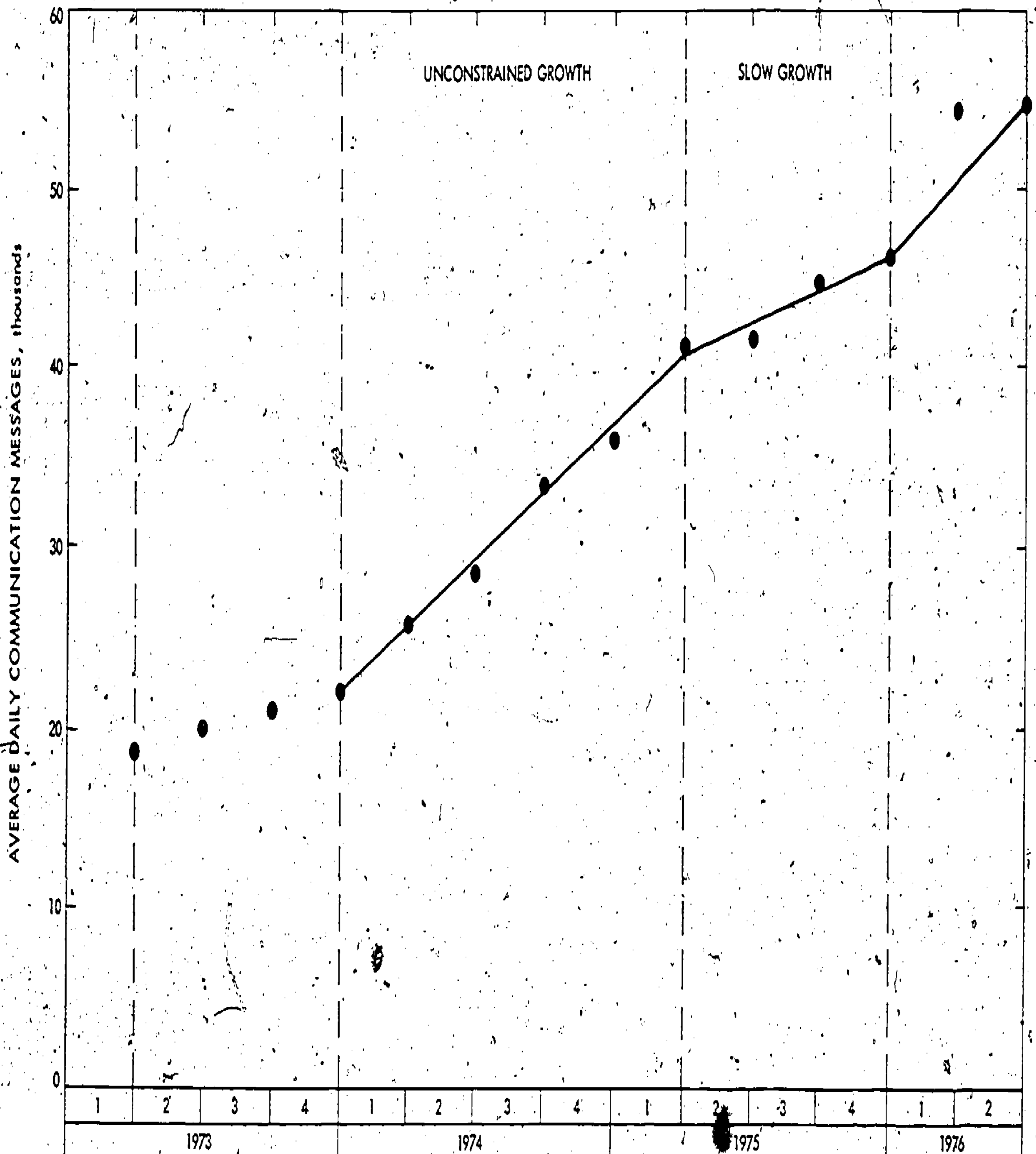


Figure 6-12. Baseline Growth

Regional information systems have historically increased traffic into a state telecommunication system. To determine the status of such systems and their potential impact on future traffic we conducted a telephone survey of all existing and planned regional systems in Texas. We asked the following questions:

(1) Is your system an existing one or just in the planning stages?

(2) What types of criminal justice agencies are served by your agency?

(3) What type of data files do you maintain?

(4) Which particular agencies does your system serve?

(5) How many terminals tie into your system?

(6) Are messages automatically forwarded from your system to TLETS?

(7) Do you allow access to your data files by the general TLETS user?

(8) Other

What are your future plans?

Any other comments?

Responses were obtained from 12 of the 13 regional systems and are shown in Figure 6-13.

In regard to traffic increases caused by regional information centers, we forecast increases from El Paso, Waco and Garland when they become fully operational. Increases were also predicted from Houston because 130 new terminals are being added, and Tarrant County because they are allowing access to their data file by all Police Departments in Tarrant County. The total increase by 1985 will be 11,000 messages per day.

Currently, there are no law enforcement agencies in Texas equipped with mobile digital terminals. In estimating their future implementation schedule, we talked with police department planners and MDT vendors. We concluded that by 1985, MDTs would be implemented in Dallas, Houston and San Antonio but not in smaller departments. This corresponds to between 1,000 and 1,500 MDT units by 1985 and will result in an increase in traffic of 23,000 messages per day.

The topic of the one port per state NCIC requirement was discussed in Section 3.4.4.2 with the increase in TLETS traffic being 13,800 messages per day.

WICHITA FALLS	GARLAND P. D.	FORT WORTH P. D.	TARRANT COUNTY	DALLAS P. D.	SAN ANTONIO
1) EXISTING	1) EXISTING		1) EXISTING	1) EXISTING	1) EXISTING
2) P. D., COURT	2) P. D.		2) COURTS	2) P. D. - COURTS	2) P. D. AND COURTS
3) MUNI. COURT REC. PERSONS	3) ARTICLES EVENTS CRIM. HIST. STO. PROPERTY GEOCODING		3) WARRANTS SUBJECT IN PROCESS (COMPLETE COURT RECORDS)	3) REG. WANTED PERSONS STOLEN ARTICLES	3) NAME FILE BOOKING RECORDS JUDICIAL REC. SYSTEM WARRANT SYSTEM MUNI. COURT WARRAN ARREST DISPOSITION
4) WICHITA FALLS P. D. MUNI. COURTS	4) GARLAND P. D.		4) COURTS, DIST. ATTN., JUST. OF PEACE	4) DALLAS P. D. OTHER P.D.'s 8 OR 9 COURTS	4) SAN ANT. P. D. COURTS FBI SECRET SERVICE
5) 6	5) 14		5) 55	5) DALLAS P. D. - 90 OTHERS - ?	5) 200
6) NO	6) NO		6) NO	6) YES	6)
7) ACCESS NONE	7) ACCESS NONE		7) ACCESS NONE CURRENTLY, PLAN TO ALLOW P.D.s IN TARRANT CO. TO ACCESS FILES POSS. OF DIRECT COMM. BETWEEN REG. SYSTEMS	7) ACCESS 11 ADJACENT COUNTIES BORDERING DALLAS AND TARRANT COUNTIES. 50 AGENCIES NO PLANS FOR EXPANSION	7) ACCESS WOULD LIKE TO HAVE ACCESS TO HOUSTON, DALLAS DATA
	8) OTHER WILL INTERFACE WITH SEPARATE COURT INFO. SYSTEM SERVICING GARLAND SYSTEM WILL BE FULLY OPERATIONAL IN DEC., 7?		8) OTHER a) NO CCH UPDATING. THIS IS DONE BY ARRESTING AGENCY	8) OTHER a) MDT's 10 IN-CAR-TERMINALS EXPANSION TO 250-300 POSSIBLE b) FEELS TRAFFIC FROM HOUSTON, SAN ANTONIO, FT WORTH WILL INCREASE c) UNACCEPTABLE TCIC RESPONSE TIMES DURING PEAK HOURS	

Figure 6-13. Regional Texas Information System Survey Sur

RIS COUNTY	AUSTIN P. D.	CORPUS CHRISTIE	EL PASO	WACO	DALLAS COUNTY
EXISTING COURT, CORRECTION BOOKING REC. JAIL INMATE RECORDS COURT ACTIVITY a) DOCUMENTS b) APPEARANCES c) WITNESSES HARRIS CO. COURTS 135 ACCESS a) NO IMMEDIATE PLANS POSS. HOUS-GALVES C.O.G. b) INTERFACE WITH HOUSTON P.D. COMP. OTHER LOW TRAFFIC LEVELS INTO TLETS	1) EXISTING 2) P. D. 3) WARRANTS 4) AUSTIN P. D. 5) 6 6) 7) ACCESS NONE 8) OTHER PLANS TO EXPAND NUMBER OF TERM. JOIN WITH MUNI. COURTS CASE ENTRY PARKING FINE	1) EXISTING 2) P. D. 3) WARRANTS STO. VEH. BOOKING REC. 4) CORPUS CHRISTIE P. D. 5) 6 6) 7) ACCESS NONE	1) PLANNED 2) WILL BE P. D. 3) WILL HAVE WARRANTS STO. VEH. 4) EL PASO P. D. ONLY 5) 6) 7) ACCESS NONE 8) IMPLEMENTATION UNCERTAIN	1) PLANNED 1978-1980 2) P. D. ONLY 3) JAIL RECORDS TRAFFIC FINES PARKING FINES 4) WACO P. D. ONLY 5) 6) 7) ACCESS NONE	1) EXISTING 2) COURT 3) LOCAL WARRANTS SUBJECTS IN PROCESS BOOKING 4) DALLAS CO. COURTS 5) 250 6) COURT DISPOSITION, WARRANTS AND REC. UPDATE 7) ACCESS OPEN TO TLETS USER. ONLY REGIONAL PEOPLE INQUIRE.

HOUSTONS P.D.	HARRIS COUNTY	AUSTIN P. D.	CORPUS CHRISTIE	EL PASO	WACO
1) EXISTING	1) EXISTING	1) EXISTING	1) EXISTING	1) PLANNED	1) PLANNED 1978-1980
2) LAW ENF.	2) COURT, CORRECTION	2) P. D.	2) P. D.	2) WILL BE P. D.	2) P. D. ONLY
3) STOLEN VEH. BICYCLE REGISTRATION MASTER NAME FILE a) WANTED PERSONS b) ALIASES c) LIC. PLATES ASSOC. WITH WANTED PERSONS GEOGRAPHIC	3) BOOKING REC. JAIL INMATE RECORDS COURT ACTIVITY a) DOCUMENTS b) APPEARANCES c) WITNESSES	3) WARRANTS	3) WARRANTS STO. VEH. BOOKING REC.	3) WILL HAVE WARRANTS STO. VEH.	3) JAIL RECORDS TRAFFIC FINES PARKING FINES
4) HOUSTON P.D.	4) HARRIS CO. COURTS	4) AUSTIN P. D.	4) CORPUS CHRISTIE P. D.	4) EL PASO P. D. ONLY	4) WACO P. D. ONLY
5) 54	5) 135	5) 6	5) 6	5)	5)
6)	6)	6)	6)	6)	6)
7) ACCESS a) NOT TO GEN. TLETS USER b) MAY CONNECT NEARBY COMMUNITIES DIRECTLY TO HPD COMP.	7) ACCESS a) NO IMMEDIATE PLANS POSS. HOUS-GALVES C.O.G. b) INTERFACE WITH HOUSTON P.D. COMP.	7) ACCESS NONE	7) ACCESS NONE	7) ACCESS NONE	7) ACCESS NONE
8) OTHER MAJOR UPGRADE ON-GOING. 130 NEW TERMINALS WILL BE ADDED IN NEXT 2 yr	8) OTHER LOW TRAFFIC LEVELS INTO TLETS	8) OTHER PLANS TO EXPAND NUMBER OF TERM. JOIN WITH MUNI. COURTS CASE ENTRY PARKING FINE		8) IMPLEMENTATION UNCERTAIN	

In this section we have presented the baseline rate of traffic increase and increases due to system improvements. After discussing growth in traffic due to new data types in Section 6.2 we will use the increases of this section and combine them with the new data type projections to give total future Texas traffic growth in Section 6.3.

6.2 NEW DATA TYPES

Tables 6-5 through 6-26 present the projected new data traffic volumes in Texas for 1977 through 1985. Traffic volumes are shown in average messages per day and in peak characters per minute. Traffic volumes of each type of new data are displayed separately. The total traffic from new data in average messages per day is shown in tabular form in Table 6-25, and in graphical form in Figure 1-2.

Table 6-5 is a guide to the tables describing the Texas new data type traffic projections. In addition to summarizing the contents of each table, it lists the sections in this report which explain the derivation of the traffic volumes.

Table 6-5. Guide to Texas Criminal Justice Information System New Data Type Traffic Projections with Reference to Methodology

Table Number	Topic	Description of Methodology
6-6	Computation of Average Messages per Day for Texas CCH/OBTS Use	4.4.2.1.1
6-7	Texas Law Enforcement CCH/OBTS Average Message Length Computation for 1977 and 1979	4.4.2.1.2
6-8	Texas Law Enforcement CCH/OBTS Average Message Length Computation for 1981 through 1985	4.4.2.1.2
6-9	Average Message Length Computations for Texas Court, Corrections and Parole Use of CCH/OBTS Files	4.4.2.1.2
6-10	Statewide Texas CCH/OBTS Traffic to and from Austin TCIC for 1977 through 1985 in Peak Characters per Minute	4.4.2.1.3
6-11	Distribution of Texas Court CCH/OBTS Traffic in Peak Characters per Minute	4.4.2.1.4
6-12	Distribution of TDC CCH/OBTS Traffic in Peak Characters per Minute	4.4.2.1.4

Table 6-5. Guide to Texas Criminal Justice Information System New Data Type Traffic Projections with Reference to Methodology (Continuation 1)

Table Number	Topic	Description of Methodology
6-13	Computation of Texas Average Automated Fingerprint Messages per Day	4.4.2.2.1 and 6.4.2.1.1
6-14	Distribution of Texas Automated Fingerprint Traffic in Peak Characters per Minute	4.4.2.2.3
6-15	Computation of Average Messages per Day for OBSCIS System	4.4.3.1.1
6-16	Computation of Average Message Length for OBSCIS Data	4.4.3.1.2
6-17	Distribution of Texas OBSCIS Traffic in Peak Characters per Minute	4.4.3.1.3
6-18	Computation of Average Texas Youth Council (TYC) Messages per Day	4.4.3.2.1
6-19	Computation of Average TYC Message Length	4.4.3.2.2
6-20	TYC Traffic Distribution in Peak Characters per Minute	4.4.3.2.3
6-21	Computation of Texas Average Messages per Day for SJIS System	4.4.4.1.1
6-22	Distribution of Texas SJIS Traffic in Peak Characters per Minute	4.4.4.1.2, and 4.4.4.1.3
6-23	Distribution of Combined Texas Court CCH/OBTS and SJIS Traffic in Peak Characters per Minute	
6-24	Texas ICR Data Conversion Traffic: Average Messages per Day, Peak Characters per Minute, and Computation of Average Message Length	4.4.4.2
6-25	Summary of Total Texas New Data Type Traffic in Average Messages per day for 1977 through 1985	
6-26	Summary of Texas New Data Type Average Message Lengths by Data Type and by Year	

Table 6-6. Computation of Average Messages per Day for Texas CCH/OBTS Use

(Refer to Section 4.4.2.1.1 for Methodology)

Factor	1977	1979	1981	1983	1985
			Year		
Estimated Arrests per year:	565,146	587,718	610,290	632,862	655,434
Technology penetration factor:					
Law enforcement	0.08	0.1	0.2	0.5	0.5
Courts	0	0	0	0.207	0.538
TDC	0	0	0.1	0.3	1.0
BPP	0	0	0.1	0.3	1.0
CCH/OBTS transactions per arrest:					
Law enforcement	12.1	12.1	19.91	19.91	19.91
Courts	6.08	6.08	6.08	6.08	6.08
TDC	0.25	0.25	0.25	0.25	0.25
BPP	0.24	0.24	0.24	0.24	0.24
Number of messages per transaction:	2	2	2	2	2
Time conversion factor: convert annual to daily average					
Law enforcement	1/365	1/365	1/365	1/365	1/365
Courts	1/250	1/250	1/250	1/250	1/250
TDC	1/250	1/250	1/250	1/250	1/250
BPP	1/250	1/250	1/250	1/250	1/250

Table 6-6. Computation of Average Messages per Day for Texas CCH/OBTS Use (Continuation 1)

(Refer to Section 4.4.2.1.1 for Methodology)

Factor	1977	1979	1981	1983	1985
Result: average messages per day for CCH/OBTS usage					
Law enforcement	3,000	3,897	13,317	34,523	35,754
Courts	0	0	0	6,367	17,138
TDC	0	0	122	380	1,311
BPP	0	0	122	380	1,311

(Year spans columns 1977–1985.)

Table 6-7. Texas Law Enforcement CCH/OBTS Average Message Length Computation for 1977 and 1979 in Characters. Assumes inquiries only and hits on one-third of inquiries

(Refer to Section 4.4.2.1.2 for Methodology)

Operation	Transactions per Arrest	Message Lengths To TCIC	Message Lengths From TCIC	Weighted Average Message Lengths To TCIC	Weighted Average Message Lengths From TCIC	Average to/from TCIC
Police inquiry	11.1	80	0.67 x 80 0.33 x 960	73	339	206
Prosecutor inquiry	0.8	80	0.67 x 80 0.33 x 960	5	24	15
Jail inquiry	0.01	80	0.67 x 80 0.33 x 960	0	0	0
Probation inquiry	0.19	80	0.67 x 80 0.33 x 960	2	7	4
Totals	12.1			80	370	225

Table 6-8. Texas Law Enforcement CCH/OBTS Average Message Length Computation for 1981 through 1985 in Characters. Assumes inquiries and entries from users.

(Refer to Section 4.4.2.1.2 for Methodology)

Operation	Transactions per Arrest	Message Lengths To TCIC	 From TCIC	Weighted Average Message Lengths To TCIC	 From TCIC	Average to/from TCIC
Police inquiry	11.1	80	0.6 x 960 0.4 x 80	45	379	212
Policy entry	4.9	960	80	236	20	128
Prosecutor inquiry	0.8	80	960	3	39	21
Prosecutor entry	2.5	960	80	121	10	66
Jail inquiry	0.01	80	960	0	0	0
Jail entry	0.02	960	80	1	0	1
Probation inquiry	0.19	80	960	1	9	5
Probation entry	0.39	960	80	19	2	10
Totals	19.91			426	459	443

Table 6-9. Average Message Length Computations for Texas Court, Corrections, and Parole Use of CCH/OBTS Files in Characters

(Refer to Section 4.4.2.1.2 for Methodology)

Operation	Transactions per Arrest	Message Lengths: To TCIC	Message Lengths: From TCIC	Weighted Average Message Lengths: To TCIC	Weighted Average Message Lengths: From TCIC	Average to/from TCIC
Court CCH/OBTS Use						
Inquiry	1.29	80	960	17	204	111
Entry	4.79	960	80	756	63	409
Totals	6.08			773	267	520
Corrections CCH/OBTS Use						
Inquiry	0.04	80	960	13	154	84
Entry	0.21	960	80	806	67	436
Totals	0.25			819	221	520
BPP CCH/OBTS Use						
Inquiry	0.04	80	960	13	160	87
Entry	0.2	960	80	800	67	433
Totals	0.24			813	227	520

Table 6-10. Statewide Texas CCH/OBTS Traffic to and from Austin TCIC for 1977-1985 in Peak Characters per Minute

(Refer to Section 4.4.2.1.2 for Methodology.)

	Year									
	1977		1979		1981		1983		1985	
Traffic Component	To TCIC	From TCIC	To TCIC	From TCIC	To TCIC	From TCIC	To TCIC	From TCIC	To TCIC	From TCIC
Law enforcement CCH/OBTS use	167	771	217	1,002	3,942	4,248	10,219	11,013	10,583	11,406
Court CCH/OBTS use	0	0	0	0	0	0	10,251	3,540	27,592	9,529
TDC CCH/OBTS use	0	0	0	0	207	57	646	179	2,229	616
BPP CCH/OBTS use	0	0	0	0	207	57	646	179	2,229	616

Table 6-11. Distribution of Texas Court CCH/OBTS Traffic in Peak Characters per Minute (Refer to Section 4.4.2.1.4 for Methodology)

City	To TCIC	From TCIC
1983		
Dallas-Fort Worth	10,251	3,540
Total	10,251	3,540
1985		
Dallas-Fort Worth	10,350	3,660
Houston	9,464	3,268
San Antonio	4,466	1,439
El Paso	1,656	572
Austin	1,656	572
Total	27,592	9,511

Table 6-12. Distribution of TDC CCH/OBTS Traffic in Peak Characters per Minute (Refer to Section 4.4.2.1.4 for Methodology)

				To TCIC	From TCIC
1981					
Huntsville ~~TDC~~ Headquarters				207	57
1983					
Huntsville TDC Headquarters				646	179
1985					
Institution	Town	County	Inmates		
TDC Headquarters	Huntsville	Walker	1,840	741	206
Coffield	Palestine	Anderson	2,316	183	50
Eastham	Fodice	Houston	2,304	182	50
Ellis	Riverside	Walker	2,094	165	46
Ferguson	Weldon	Houston	1,922	151	42
Wynne	Huntsville	Walker	1,800	142	39
Ramsey I	Angleton	Brazoria	1,632	129	36
Clemens	Brazoria	Brazoria	1,119	88	24

Table 6-12. Distribution of TDC CCH/OBTS Traffic in Peak Characters per Minute (Continuation 1)
(Refer to Section 4.4.2.1.4 for Methodology)

Institution	Town	County	Inmates	To TCIC	From TCIC
Ramsey II	Angleton	Brazoria	981	77	21
Darrington	Alvin	Brazoria	844	67	18
Jester	Stafford	Ft. Bend	844	67	18
Retrieve	Angleton	Brazoria	767	60	17
Central	Stafford	Ft. Bend	767	60	17
Huntsville Diagnostic	Huntsville	Walker	664	52	14
Goree	Huntsville	Walker	483	38	11
Mountain View	Coryell	Coryell	340	27	7
Totals			20,717	2,229	616

Table 6-13. Computation of Texas Average Automated Fingerprint Messages per Day
(Refer to Sections 4.4.2.2.1 and 4.4.2.1.1 for Methodology)

Factor	1977	1979	Year 1981	1983	1985
Estimated arrests in Texas per year:	565,146	587,718	610,290	632,862	655,434
Technology penetration factor:	0	0	0.207	0.392	0.506
Fingerprint transactions per arrest:	2.18	2.18	2.18	2.18	2.18
Messages per fingerprint transaction:	2	2	2	2	2
Time conversion; annual to daily average:	1/250	1/250	1/250	1/250	1/250
Automated fingerprint traffic in messages per day:	0	0	2,203	4,326	5,784

Table 6-14. Distribution of Texas Automated Fingerprint Traffic in Peak Characters per Minute

(Refer to Section 4.4.2.2.3 for Methodology)

Source	1981 To TCIC	1981 From TCIC	1983 To TCIC	1983 From TCIC	1985 To TCIC	1985 From TCIC
Dallas-Fort Worth	8,504	1,278	8,921	1,340	9,263	1,392
Houston			7,777	1,169	8,075	1,214
San Antonio					3,563	535
El Paso					1,425	214
Totals	8,504	1,278	16,698	2,509	22,326	3,355

Table 6-15. Computation of Average Messages per Day for Texas OBSCIS System (Refer to Section 4.4.3.1.1 for Methodology)

Factor	1977	1979	Year 1981	1983	1985
TDC inmates	20,717	24,773	28,849	32,925	37,000
Technology penetration factor	0	0	0.1	0.3	1.0
Transactions per inmate-day	0.175	0.175	0.175	0.175	0.175
Messages per transaction	2	2	2	2	2
OBSCIS traffic (average messages per day)	0	0	1,010	3,457	12,950

170

Table 6-16. Computation of Average Message Length for Texas OBSCIS Data

(Refer to Section 4.4.3.1.2 for Methodology)

Message Type	Transactions per Inmate-Day	Message Length		Average Message Length		
		To TDC	From TDC	To TDC	From TDC	Average to/from TDC
TDC data entry	0.071	480	80	195	32	114
TDC inquiry	0.071	80	960	32	389	210
BPP inquiry	0.033	80	480	15	91	53
Totals	0.175			242	512	377

Table 6-17. Distribution of Texas OBSCIS Traffic in Peak Characters per Minute (Refer to Section 4.4.3.1.3 for Methodology)

				To TDC	From TDC
1981					
TDC Headquarters				409	876
BPP Headquarters				96	205
Totals				505	1,081
1983					
TDC Headquarters				1,400	2,996
BPP Headquarters				329	703
Totals				1,729	3,699
1985					
Institution	Town	County	Inmates		
TDC Headquarters	Huntsville	Walker	1,840	1,745	3,734
BPP Headquarters	Austin	Travis	None	1,230	2,633
Coffield	Palestine	Anderson	2,316	429	919
Eastham	Fodice	Houston	2,304	427	914
Ellis	Riverside	Walker	2,094	388	831
Ferguson	Weldon	Houston	1,922	356	763
Wynne	Huntsville	Walker	1,800	334	714
Ramsey I	Angelton	Brazoria	1,632	303	648
Clemens	Brazoria	Brazoria	1,119	207	444
Ramsey II	Angelton	Brazoria	981	182	389
Darrington	Alvin	Brazoria	844	157	335
Jester	Stafford	Ft. Bend	844	157	335
Retrieve	Angelton	Brazoria	767	142	304
Central	Stafford	Ft. Bend	767	142	304
Huntsville Diagnostic	Huntsville	Walker	664	123	263
Goree	Huntsville	Walker	483	90	192
Mountain View	Coryell	Coryell	340	63	135
Totals			20,717	6,475	13,857

Table 6-18. Computation of Average Texas Youth Council (TYC) Messages per Day (Refer to Section 4.4.3.2.1 for Methodology)

Factor	1977	1979	Year 1981	1983	1985
TYC students	1,835	2,196	2,557	2,918	3,280
Technology penetration factor	0	0.5	1.0	1.0	1.0
Transactions per student-day	0.26	0.26	0.26	0.26	0.26
Messages per transaction	2	2	2	2	2
TYC traffic in average messages per day	0	571	1,330	1,517	1,706

Table 6-19. Computation of Average TYC Message Length in Characters (Refer to Section 4.4.3.2.2 for Methodology)

Message Type	Transactions per Student-Day	Message Length: To TYC	Message Length: From TYC	Average Message Length: To TYC	Average Message Length: From TYC	Average Message Length: Average to/from TYC
Entry	0.13	480	80	240	40	140
Inquiry	0.13	80	960	40	480	260
Totals	0.26			280	520	400

173

Table 6-20. TYC Traffic Distribution in Peak Characters per Minute

(Refer to Section 4.4.3.2.3 for Methodology)

Institution	Town	County	Number of Students	1979 To TYC	1979 From TYC	1981 To TYC	1981 From TYC	1983 To TYC	1983 From TYC	1985 To TYC	1985 From TYC
TYC Headquarters	Austin	Travis	0	333	618	194	360	221	411	249	462
Brownwood	Brownwood	Brown	200	0	0	194	360	221	411	249	462
Gatesville	Gatesville	Coryell	600	0	0	139	258	156	295	177	332
Gainesville	Gainesville	Cooke	275	0	0	62	115	71	131	80	148
Giddings	Giddings	Lee	270	0	0	62	115	71	131	80	148
Corsicana	Corsicana	Navarro	130	0	0	31	58	36	66	40	74
Pyote	Pyote	Ward	130	0	0	31	58	36	66	40	74
Waco	Waco	McLennan	130	0	0	31	58	36	66	40	74
Crockett	Crockett	Houston	100	0	0	31	58	36	66	40	74
Totals			1,835	333	618	775	1,440	884	1,643	995	1,848

Table 6-21. Computation of Texas Average Messages per Day for SJIS System (Refer to Section 4.4.4.1.1 for Methodology)

Factor	1977	1979	1981	1983	1985
Court dispositions	656,660	718,013	779,366	840,719	902,072
Technology penetration factor	0	0	0	0.207	0.538
Transactions per disposition	1	1	1	1	1
Messages per transaction	2	2	2	2	2
Time conversion factor	1/250	1/250	1/250	1/250	1/250
SJIS traffic (average messages per day)	0	0	0	1,392	3,883

Table 6-22. Distribution of Texas SJIS Traffic in Peak Characters per Minute (Refer to Sections 4.4.4.1.2, and 4.4.4.1.3 for Methodology. This table assumes 1920-character data entries to Austin and 80-character acknowledgments to courts)

City	Traffic To Austin	Traffic From Austin
1983		
Dallas-Fort Worth	5,568	232
1985		
Dallas-Fort Worth	5,981	249
Houston	5,327	222
San Antonio	2,345	98
El Paso	947	39
Austin	932	39
Totals	15,532	647

Table 6-23. Distribution of Combined Texas Court CCH/OBTS and SJIS Traffic in Peak Characters per Minute

City and Year	Traffic To Austin	Traffic From Austin
1983		
Dallas-Fort Worth	15,819	3,172
1985		
Dallas-Fort Worth	16,331	3,909
Houston	14,791	3,490
San Antonio	6,811	1,537
El Paso	2,603	611
Austin	2,588	611
Totals	43,124	10,176

177

Table 6-24. Texas ICR Data Conversion Traffic: Average Messages per Day, Peak Characters per Minute Computation of Average Message Length in Characters

(Refer to Section 4.4.4.2 for Methodology)

Traffic Volume

Inquiries per day: 1,500
Data entries per day: 1,500
Total average transactions per day: 3,000
Average messages per day: 6,000
Peak characters per minute: 4,698 to TCIC
4,302 from TCIC

Average Message Length Computation:

Operation	Transactions per Arrest	Message Length: To TCIC	Message Length: From TCIC	Weighted Average Message Lengths: To TCIC	Weighted Average Message Lengths: From TCIC	Weighted Average Message Lengths: Average to/from TCIC
Inquiry	1.0	80	0.6 x 960 0.4 x 80	40	304	172
Entry	1.0	0.6 x 480 0.4 x 960	80	336	40	188
Totals	2.0			376	344	360

Table 6-25. Total Texas New Data Type Traffic in Average Messages per Day

Data Type	1977	1979	1981	1983	1985
ICR data conversion	6,000	6,000	6,000	6,000	6,000
Law enforcement CCH/OBTS	3,000	3,897	13,317	34,523	35,754
Court CCH/OBTS	0	0	0	6,367	17,138
Corrections CCH/OBTS	0	0	122	380	1,311
BPP CCH/OBTS	0	0	122	380	1,311
SJIS	0	0	0	1,392	3,883
OBSCIS	0	0	1,010	3,457	12,950
TYC	0	571	1,330	1,517	1,706
Automated fingerprints	0	0	2,203	4,326	5,784
Totals	9,000	10,468	24,104	58,342	85,837

Table 6-26. Summary of Texas New Data Type Average Message Lengths by Data Type and by Year in Characters

	To State Center	From State Center	Average to/from State Center
<u>By Data Type</u>:			
ICR data conversion	376	344	360
Law enforcement CCH/OBTS	80/426*	370/459*	225/443*
Court CCH/OBTS	773	267	520
Corrections CCH/OBTS	819	221	520
Parole CCH/OBTS	813	227	520
SJIS	1,920	80	1,000
OBSCIS	242	512	377
Texas Youth Council	280	520	400
Automated fingerprints	1,852	279	1,066
<u>By Year for All New Data Types</u>:			
1977	278	352	315
1979	261	363	312
1981	531	417	474
1983	588	403	496
1985	638	384	511

*First number is average message length in 1977 and 1979; second is average message length in 1981, 1983, 1985.

6.3 EXISTING AND NEW DATA TYPES COMBINED

This section combines the projections for the gro h existing criminal justice information data types from Section th the estimate for future new data type traffic from Section 6.2 obtain a total criminal justice information system traffic projection for Texas. The methodologies used to project future growth in existing traffic types are explained in Section 3, and the techniques used to estimate the start and growth of traffic in new data types are described in Section 4.

6.3.1 Traffic Projections

The three growth components are baseline growth, growth due to system improvements and traffic into new data bases. Table 6-27 presents potential new traffic caused by system improvements and new data type traffic. The values in the table are the increases in traffic above the previous 6-month period.

The word potential is used because if these traffic increases cause total traffic to exceed system capacity then the increases will be delayed.

We will now summarize procedures used for projecting future growth and show the results. Procedures used are:

(1). Periods of 6-month duration will be used.

(2) Due to baseline growth, traffic is 4,200 messages per day higher one period after an upgrade, 10,200 messages per day higher two periods after an upgrade and 17,900 messages per day higher three periods after an upgrade. After the third period traffic is 7,700 messages per day higher each subsequent period.

(3). System improvement traffic growth and new data type traffic growth occur as specified in Table 6-27.

(4) Current system capacity in Texas is 150,000 messages per day.

(5) Traffic grows each period until a period is reached where projected traffic exceeds system capacity. At this point, all three components of traffic growth are reduced so that total traffic is less than system capacity by 3,000 messages per day. During the next period a 150,000 average message per day increase in system capacity is assumed. The increase in average daily message volume due to baseline growth is 4,200 messages per day. Growth due to system improvements and new data type traffic is the sum of the growth specified in Table 6-27 and the amount of the reduction during the previous period. In subsequent periods traffic continues to grow until once again system capacity is reached.

Table 6-27. Increase in Texas Average Daily Communication Messages

Six Month Period	System Improvement Traffic	New Data Type Traffic
77	46,300	1100
77/78	9,500	400
78	2,400	400
78/79	1,400	400
79	14,200	400
79/80	200	3400
80	600	3400
80/81	400	3400
81	400	3400
81/82	400	8600
82	400	8600
82/83	0	8600
83	10,500	8600
83/84	0	6900
84	0	6900
84/85	0	6900
85	0	6900

Tables 6-28 and 6-29 show the application of these procedures to Texas. Note that capacity increases are required in periods '77 and '82. Table 6-29 shows that by 1985 almost 400,000 messages per day will be transmitted over the TLETS system. Traffic projections are also presented in peak characters per minute to show how the longer message lengths of the new data types cause them to contribute a larger portion of the traffic in units of characters per minute.

181

Table 6-28. Texas Traffic Growth Each Six Months - 1975-1985

Starting 110,000

76/77	BG	7,700		
	SU	0		
	NDT	1,100		
			8,800	118,800
77	BG	7,700		
	SU	46,300		
	NDT	1,100		
			55,100	173,900*
	BG	3,940		
	SU	23,700		
	NDT	560		
			28,200	147,000
77/78	BG	4,200		
	SU	32,100		
	NDT	940		
			37,200	184,200
78	BG	6,000		
	SU	2,400		
	NDT	400		
			8,800	193,000
78/79	BG	7,700		
	SU	1,400		
	NDT	400		
			9,500	202,500
79	BG	7,700		
	SU	14,200		
	MDT	400		
			22,300	224,800
79/80	BG	7,700		
	SU	200		
	NDT	3,400		
			11,300	236,100
80	BG	7,700		
	SU	600		
	NDT	3,400		
			11,700	247,800
80/81	BG	7,700		
	SU	400		
	NDT	3,400		
			11,500	259,300
81	BG	7,700		
	SU	400		
	NDT	3,400		
			11,500	270,800
81/82	BG	7,700		
	SU	400		
	NDT	8,600		
			16,700	287,500
82	BG	7,700		
	SU	400		
	NDT	8,600		
			16,700	304,200*
	BG	4,380		
	SU	230		
	NDT	4,890		
			9,500	297,000
82/83	BG	4,200		
	SU	170		
	NDT	12,300		
			16,700	313,700
83	BG	6,000		
	SU	10,500		
	NDT	8,600		
			25,100	338,800
83/84	BG	7,700		
	SU	0		
	NDT	6,900		
			14,600	353,400
84	BG	7,700		
	SU	0		
	NDT	6,900		
			14,600	368,000
84/85	BG	7,700		
	SU	0		
	NDT	6,900		
			14,600	382,600
85	BG	7,700		
	SU	0		
	NDT	6,900		
			14,600	397,200

LEGEND:

BG - Baseline Growth
SU - System Upgrade
NDT - New Data Type

*Exceeds capacity.

182

Table 6-29. Texas Traffic Growth by Two Year Periods

Traffic Summary: Average messages per day

	Existing Law Enforcement Traffic	New Data Type Traffic	Total Statewide Traffic
77	138,490	8,400	146,900
79	214,190	10,600	224,800
81	246,600	24,200	270,800
83	280,200	58,500	338,700
85	311,000	86,140	397,100

Traffic Summary: Peak Characters per Minute

	Existing Law Enforcement Traffic	New Data Type Traffic	Total Statewide Traffic
77	21,160	3,700	24,860
79	32,720	4,670	37,390
81	37,670	15,960	53,630
83	42,810	40,220	83,030
85	47,510	61,010	108,520

6.3.2 Traffic Distribution - Texas Traffic Distribution Results

Distribution of messages to users in Texas is discussed in detail in Section 3 and needs no further discussion here. However, the results of the distribution task are presented in Table 6-30 for 1985. The table shows the projected traffic in units of peak characters per minute to and from TLETS data bases for each of the approximately 600 terminals projected to be in the state criminal justice telecommunications system. The six traffic entries represent traffic to and from Austin, to and from Dallas and to and from San Antonio. Only terminals in close proximity to Dallas or San Antonio will have access to their data files.

In addition to determining the amount of traffic to and from each terminal, we must determine the distribution of total traffic by message type. This is needed to calculate the overall message length into and out of the computers and also over the communication network. It is also used to determine computer transactions given communication messages.

Table 6-31 shows our projections for this distribution in 1985. Units are average messages per day and peak characters per minute.

Table 6-30. Texas 1985 Traffic To and From Each User Agency

Two lines of data are shown for each user agency. The 1st line shows user agency name, city identification number and traffic from user agency to Austin and from Austin to user agency. The 2nd line shows traffic from user agency to Dallas, from Dallas to user agency, from user agency to San Antonio, and from San Antonio to user agency. In all cases, traffic is given in units of characters per minute and represents traffic during the busiest hour.

PALESTINE PD	1	24.65	60.16	.00	.00	.00	.00
ANDREWS SO	2	8.11	18.86	.00	.00	.00	.00
LUFKIN DPS	3	28.74	91.02	.00	.00	.00	.00
LUFKIN PD	3	40.37	83.06	.00	.00	.00	.00
ROCKPORT PD/SO	4	6.71	21.25	.00	.00	.00	.00
ARCHER CITY SO	5	2.89	7.39	.00	.00	.00	.00
JOURDANTON SO	6	14.21	35.90	.00	.00	1.82	7.74
BELLVILLE SO	7	5.11	12.16	.00	.00	.00	.00
MULESHOE PD	8	7.35	19.23	.00	.00	.00	.00
SEYMOUR SO	9	5.03	11.54	.00	.00	.00	.00
BEEVILLE PD	10	14.97	30.39	.00	.00	.00	.00
BELTON PD	11	11.27	25.60	.00	.00	[illegible]	.00
BELTON SO	11	34.65	83.88	.00	.00	.00	.00
FORT HOOD PMO	12	18.16	57.50	.00	.00	.00	.00
HARKER HEIGHTS PD	13	9.36	21.95	.00	.00	.00	.00
KILLEEN PD	14	76.78	131.84	.00	.00	.00	.00
NOLANVILLE PD	15	7.18	20.90	.00	.00	.00	.00
TEMPLE PD	16	72.58	131.90	.00	.00	.00	.00
ALAMO HEIGHTS PD	17	11.23	23.51	.00	.00	1.01	1.51
FT SAM HOUSTON PMO	18	11.01	34.88	.00	.00	2.04	4.06
LEON VALLEY PD	19	16.02	35.33	.00	.00	1.60	7.40
SAN ANTONIO COMP	20	1750.89	3393.58	.00	.00	.00	.00
SAN ANTONIO CSTMS	20	8.95	28.3[illegible]	.00	.00	1.66	7.49
SAN ANTONIO DPS	20	24.66	78.10	.00	.00	4.57	5.85
SAN ANTONIO FBI	20	5.04	15.98	.00	.00	.93	1.40
SAN ANTONIO PD	20	6.08	19.25	.00	.00	.00	.00
SAN ANTONIO PD CON	20	3.16	10.00	.00	.00	.00	.00
SAN ANTONIO PD INT	20	7.30	25.00	.00	.00	.00	.00
SAN ANTONIO SO	20	4.05	12.83	.00	.00	.75	1.13
UNIVERSAL CITY PD	21	20.68	42.55	.00	.00	1.79	7.69
CLIFTON PD	22	5.81	17.31	.00	.00	.00	.00
MERIDIAN SO	23	4.55	10.51	.00	.00	.00	.00
TEXARKANA DPS	24	19.92	63.07	.00	.00	.00	.00
TEXARKANA PD	24	49.95	101.22	.00	.00	.00	.00
TEXARKANA SO	24	35.87	70.06	.00	.00	.00	.00
ALVIN PD	25	16.13	33.95	.00	.00	.00	.00
ANGLETON PD	26	10.55	25.34	.00	.00	.00	.00
ANGLETON SO	26	43.40	100.48	.00	.00	.00	.00
CLUTE PD	27	10.34	23.0[illegible]	.00	.00	.00	.00
FREEPORT PD	28	16.45	31.95	.00	.00	.00	.00
LAKE JACKSON PD	29	13.30	29.10	.00	.00	.00	.00
PEARLAND PD	30	10.75	25.04	.00	.00	.00	.00
BRYAN DPS	31	24.22	76.69	.00	.00	.00	.00
BRYAN PD	31	52.69	103.04	.00	.00	.00	.00
COLLEGE STATION PD	32	23.04	40.93	.00	.00	.00	.00
ALPINE PD	33	9.38	26.90	.00	.00	.00	.00
FALFURRIAS SO	34	9.51	23.68	.00	.00	.00	.00
BROWNWOOD PD	35	18.72	32.88	.00	.00	.00	.00
CALDWELL SO	36	4.64	10.87	.00	.00	.00	.00
PORT LAVACA PD	37	15.92	31.68	.00	.00	.00	.00
PORT LAVACA SO	37	9.97	24.17	.00	.00	.00	.00
BROWNSVILLE PD	38	86.56	173.53	.00	.00	.00	.00
BROWNSVILLE SO	38	21.70	60.82	.00	.00	.00	.00
HARLINGEN DPS	39	.12	.38	.00	.00	.00	.00
HARLINGEN PD	39	58.49	116.23	.00	.00	.00	.00
PORT ISABEL PD	40	5.67	17.68	.00	.00	.00	.00
SAN BENITO PD	41	14.86	32.07	.00	.00	.00	.00
LINDEN SO	42	6.67	15.89	.00	.00	.00	.00
DIMMIT SO	43	3.53	7.82	.00	.00	.00	.00
ANAHUAC SO	44	6.10	13.48	.00	.00	.00	.00
JACKSONVILLE PD	45	15.83	37.12	.00	.00	.00	.00
CHILDRESS DPS	46	12.21	38.67	.00	.00	.00	.00
MORTON SO	47	4.38	10.58	.00	.00	.00	.00
ROBERT LEE SO	48	2.10	5.47	.00	.00	.00	.00
COLEMAN PD	49	6.48	19.09	.00	.00	.00	.00
FRISCO PD	50	6.49	17.65	.94	1.42	.00	.00
MCKINNEY PD	51	22.70	41.01	1.46	2.19	.00	.00
PLANO PD	52	46.77	89.00	3.41	5.11	.00	.00
WELLINGTON SO	53	3.58	7.61	.00	.00	.00	.00

Table 6-30. Texas 1985 Traffic To and From Each User Agency (Continuation 1).

COLUMBUS SO			54	[illegible]	[illegible]
.00	.00	.00		.00	
NEW BRAUNFELS PD			55	24.06	42.04
.00	.00	1.42		2.13	
COMANCHE PD			56	6.06	17.84
.00	.00	.00		.00	
[illegible]NESVILLE PD			57	16.18	34.51
.00	.00	.00		.00	
COPPERAS COVE PD			58	19.39	35.18
.00	.00	.00		.00	
GATESVILLE PD			59	8.96	21.25
.00	.00	.00		.00	
GATESVILLE SO			59	29.16	52.02
.00	.00	.00		.00	
CRANE PD			60	5.81	18.10
.00	.00	.00		.00	
OZONA DPS			61	18.50	58.58
.00	.00	.00		.00	
DALHART PD			62	7.95	21.47
.00	.00	.00		.00	
ADDISON PD			63	8.55	19.89
.94	1.42	.00		.00	
CEDAR HILL PD			64	12.24	23.40
.90	1.35	.00		.00	
DALLAS CITY COMP			65	4157.09	3964.29
.00	.00	.00		.00	
DALLAS COUNTY COMP			65	345.25	1040.02
59.20	88.80	.00		.00	
DALLAS DEA			65	33.40	105.75
6.18	9.28	.00		.00	
DALLAS DPS CONTROL			65	7.11	22.52
1.32	1.98	.00		.00	
DALLAS DPS INTCPT			65	.11	.34
.02	.03	.00		.00	
DALLAS DPS RADIO			65	33.17	105.04
6.14	9.21	.00		.00	
DALLAS DPS TWX			65	35.84	113.48
6.64	9.95	.00		.00	
DALLAS FBI			65	3.98	12.60
.74	1.11	.00		.00	
DALLAS IRS			65	2.98	9.45
.55	.83	.00		.00	
DALLAS NATB			65	32.40	102.60
6.00	9.00	.00		.00	
DALLAS PD			65	11.37	36.00
.00	.00	.00		.00	
DALLAS PD DRUG			65	1.97	6.25
.00	.00	.00		.00	
DALLAS PD ID			65	7.50	23.75
.00	.00	.00		.00	
DALLAS SO			65	10.09	31.95
1.87	2.80	.00		.00	
DESOTO PD			66	13.63	28.22
1.20	1.79	.00		.00	
DUNCANVILLE PD			67	23.46	41.60
1.44	2.16	.00		.00	
FARMERS BRANCH PD			68	39.61	81.41
3.42	5.13	.00		.00	
GARLAND PD			69	190.20	413.30
18.42	27.63	.00		.00	
GRAND PRAIRIE PD			70	100.15	169.04
5.38	8.07	.00		.00	
HIGHLAND PARK PD			71	14.51	33.03
1.54	2.31	.00		.00	
IRVING PD			72	136.84	175.12
2.39	3.58	.00		.00	
LANCASTER PD			73	16.88	32.20
1.24	1.86	.00		.00	
MESQUITE PD			74	97.79	176.07
6.23	9.35	.00		.00	
RICHARDSON PD			75	74.41	142.96
5.54	8.31	.00		.00	
SEAGOVILLE PD			76	13.91	25.93
.97	1.45	.00		.00	
SMU SECURITY POL			65	10.20	19.20
.72	1.09	.00		.00	
UNIVERSITY PARK PD			77	21.43	59.97
[illegible]	4.03	.00		.00	

LAMESA PD			78	[illegible]	33.15
.00	.00	.00		.00	
LAMESA SO			78	3.74	7.52
.00	.00	.00		.00	
HEREFORD PD			79	9.43	25.68
.00	.00	.00		.00	
HEREFORD SO			79	5.13	14.73
.00	.00	.00		.00	
DENTON PD			80	53.39	106.40
4.32	6.48	.00		.00	
DENTON SO			80	39.88	78.05
3.10	4.65	.00		.00	
LEWISVILLE PD			[illegible]	26.36	44.30
1.40	2.10	.00		.00	
CUERO SO			82	4.08	10.52
.00	.00	.00		.00	
SPUR PD			83	6.28	17.80
.00	.00	.00		.00	
SAN DIEGO SO			84	6.22	14.13
.00	.00	.00		.00	
EASTLAND PD			85	5.53	16.99
.00	.00	.00		.00	
ODESSA PD			86	125.57	220.77
.00	.00	.00		.00	
ODESSA SO			86	21.89	35.88
.00	.00	.00		.00	
ENNIS PD			87	14.18	30.42
1.34	2.01	.00		.00	
WAXAHACHIE PD			88	16.05	33.58
1.44	2.16	.00		.00	
WAXAHACHIE SO			88	11.59	19.44
.61	.92	.00		.00	
EL PASO DEA			89	1.97	6.25
.00	.00	.00		.00	
EL PASO DPS			89	26.96	85.39
.00	.00	.00		.00	
EL PASO FBI			89	4.11	13.00
.00	.00	.00		.00	
EL PASO PD			89	505.58	745.05
.00	.00	.00		.00	
EL PASO SO			89	25.02	55.13
.00	.00	.00		.00	
EL PASO US CUSTOMS			89	3.00	9.50
.00	.00	.00		.00	
FORT BLISS PMO			89	9.00	28.50
.00	.00	.00		.00	
STEPHENVILLE PD			90	13.75	39.16
.00	.00	.00		.00	
MARLIN PD			91	8.02	22.86
.00	.00	.00		.00	
MARLIN SO			91	4.07	8.13
.00	.00	.00		.00	
BONHAM PD			92	11.10	26.19
.00	.00	.00		.00	
ROBY SO			93	3.09	7.60
.00	.00	.00		.00	
FLOYDADA SO			94	5.60	11.91
.00	.00	.00		.00	
FAIRFIELD SO			95	4.65	10.61
.00	.00	.00		.00	
PEARSALL SO			96	7.46	14.44
.00	.00	.00		.00	
RICHMOND SO			97	21.39	58.12
.00	.00	.00		.00	
ROSENBERG PD			98	18.88	37.19
.00	.00	.00		.00	
SEMINOLE SO			99	10.28	19.29
.00	.00	.00		.00	
FRIENDSWOOD PD			100	9.25	22.37
.00	.00	.00		.00	
GALVESTON PD			101	124.28	200.98
.00	.00	.00		.00	
GALVESTON SO			101	38.22	73.38
.00	.00	.00		.00	
HITCHCOCK PD			102	6.46	19.07
.00	.00	.00		.00	
LA MARQUE PD			103	13.18	30.00
.00	.00	.00		.00	

Table 6-30. Texas 1985 Traffic To and From Each User Agency (Continuation 2)

LEAGUE CITY PD	104	14.07	31.47
.00	.00	.00	
TEXAS CITY PD	105	62.90	118.81
.00	.00	.00	.00
[illegible]T SO	106	2.86	8.16
.00	.00	.00	.00
FREDERICKSBURG SO	107	6.70	13.61
.00	.00	.00	.00
GOLIAD SO	108	2.99	7.24
.00	.00	.00	.00
GONZALES SO	109	6.56	15.57
.00	.00	.71	1.07
PAMPA PD	110	29.49	65.69
.00	.00	.00	.00
DENISON PD	111	34.32	70.73
.00	.00	.00	.00
SHERMAN DPS	112	19.38	61.38
.00	.00	.00	.00
SHERMAN PD	112	40.42	82.03
.00	.00	.00	.00
SHERMAN SO	112	25.91	59.50
.00	.00	.00	.00
GLADEWATER PD	113	10.93	26.27
.00	.00	.00	.00
KILGORE PD	114	15.23	31.44
.00	.00	.00	.00
LONGVIEW PD	115	58.10	123.87
.00	.00	.00	.00
LONGVIEW SO	115	12.76	24.75
.00	.00	.00	.00
NAVASOTA PD	116	8.47	22.83
.00	.00	.00	.00
SEGUIN PD	117	21.47	43.83
.00	.00	1.83	2.74
PLAINVIEW PD	118	25.27	55.61
.00	.00	.00	.00
PLAINVIEW SO	118	7.67	14.67
.00	.00	.00	.00
HAMILTON SO	119	1.73	4.53
.00	.00	.00	.00
SPEARMAN PD	120	6.03	18.07
.00	.00	.00	.00
SPEARMAN SO	120	2.33	5.19
.00	.00	.00	.00
QUANAH SO	121	3.50	8.84
.00	.00	.00	.00
KOUNTZE SO	122	21.92	38.28
.00	.00	.00	.00
SILSBEE PD	123	10.17	24.15
.00	.00	.00	.00
BAYTOWN PD	124	74.95	143.75
.00	.00	.00	.00
BELLAIRE PD	125	17.66	36.37
.00	.00	.00	.00
DEER PARK PD	126	9.72	26.76
.00	.00	.00	.00
GALENA PARK PD	127	15.95	31.71
.00	.00	.00	.00
HOUSTON CITY COMP	128	2771.15	5650.23
.00	.00	.00	.00
HOUSTON CNTY COMP	128	419.73	572.15
.00	.00	.00	.00
HOUSTON DPS	128	44.51	140.96
.00	.00	.00	.00
HOUSTON FBI	128	4.66	14.75
.00	.00	.00	.00
HOUSTON P AND W	128	12.00	38.00
.00	.00	.00	.00
HOUSTON PD	128	8.61	27.25
.00	.00	.00	.00
HOUSTON SO	128	5.13	16.25
.00	.00	.00	.00
HOUSTON SO OCU	128	3.32	10.50
.00	.00	.00	.00
HOUSTON SO WARRANT	128	.00	.00
.00	.00	.00	.00
HOUSTON US CUSTOMS	128	.39	1.25
.00	.00	.00	.00
HUMBLE PD	129	9.11	23.00
.00	.00	.00	.00
JACINTO CITY PD	130	11.49	25.31
.00	.00	.00	.00
JERSEY VILLAGE PD	131	6.75	19.64
.00	.00	.00	.00
KATY PD	132	11.27	27.15
.00	.00	.00	.00
LA PORTE PD	133	17.83	35.43
.00	.00	.00	.00
PASADENA PD	134	127.35	168.84
.00	.00	.00	.00
SEABROOK PD	135	13.32	27.82
.00	.00	.00	.00
SOUTH HOUSTON PD	136	18.79	36.39
.00	.00	.00	.00
SOUTHSIDE PLACE PD	137	7.25	19.66
.00	.00	.00	.00
SPRING VALLEY PD	138	9.63	21.98
.00	.00	.00	.00
TOMBALL PD	139	8.52	20.23
.00	.00	.00	.00
VILLAGE PD	140	25.49	42.56
.00	.00	.00	.00
WEBSTER PD	141	9.80	23.75
.00	.00	.00	.00
WEST UNIV PL PD	142	12.87	28.89
.00	.00	.00	.00
MARSHALL PD	143	31.49	69.40
.00	.00	.00	.00
MARSHALL SO	143	17.02	44.92
.00	.00	.00	.00
HASKELL SO	144	12.24	35.12
.00	.00	.00	.00
SAN MARCOS PD	145	34.12	64.57
.00	.00	.00	.00
CANADIAN SO	146	4.14	9.01
.00	.00	.00	.00
ATHENS PD	147	15.18	36.42
.00	.00	.00	.00
DONNA PD	148	11.11	26.46
.00	.00	.00	.00
EDINBURG PD	149	18.15	36.90
.00	.00	.00	.00
EDINBURG SO	149	58.95	145.21
.00	.00	.00	.00
HIDALGO PD	150	6.12	17.10
.00	.00	.00	.00
MCALLEN PD	151	73.53	137.02
.00	.00	.00	.00
MERCEDES PD	152	12.77	30.56
.00	.00	.00	.00
MISSION PD	153	18.93	35.71
.00	.00	.00	.00
PHARR PD	154	22.57	39.66
.00	.00	.00	.00
WESLACO PD	155	13.44	31.55
.00	.00	.00	.00
HILLSBORO PD	156	10.76	25.82
.00	.00	.00	.00
LEVELLAND PD	157	10.45	27.80
.00	.00	.00	.00
SULPHUR SPRGS DPS	158	21.50	68.10
.00	.00	.00	.00
SULPHUR SPRINGS PD	158	21.56	44.54
.00	.00	.00	.00
BIG SPRINGS PD	159	48.72	91.88
.00	.00	.00	.00
BIG SPRINGS SO	159	3.66	10.32
.00	.00	.00	.00
COMMERCE PD(RD)	160	10.01	23.83
1.15	1.73	.00	.00
GREENVILLE PD	161	39.70	71.92
2.57	3.86	.00	.00
BORGER PD	162	18.92	35.96
.00	.00	.00	.00

Table 6-30. Texas 1985 Traffic To and From Each User Agency (Continuation 3)

JACKSBORO SO	163	3.04	7.55	.00	.00	.00	.00
EDNA SO	164	5.61	13.98	.00	.00	.00	.00
BEAUMONT DPS	165	.12	.38	.00	.00	.00	.00
AUMONT PD	165	220.23	332.38	.00	.00	.00	.00
BEAUMONT SO	165	38.69	97.63	.00	.00	.00	.00
NEDERLAND PD	166	16.28	32.07	.00	.00	.00	.00
PORT ARTHUR PD	167	72.73	141.23	.00	.00	.00	.00
ALICE PD	168	29.63	61.63	[illegible]	.00	.00	.00
BURLESON PD	169	12.76	26.11	1.09	1.64	.00	.00
CLEBURNE PD	170	24.29	56.47	2.68	4.02	.00	.00
ANSON SO	171	7.75	21.77	.00	.00	.00	.00
STAMFORD PD	172	7.17	19.30	.00	.00	.00	.00
KARNES CITY SO	173	5.71	13.06	.00	.00	.00	.00
KAUFMAN SO	174	13.96	20.84	.51	.76	.00	.00
TERRELL PD	175	21.22	38.95	1.42	2.13	.00	.00
BOERNE SO	176	2.95	7.98	.00	.00	.43	.64
JAYTON SO	177	2.51	5.37	.00	.00	.00	.00
KERRVILLE DPS	178	29.98	94.93	.00	.00	.00	.00
KERRVILLE PD	178	25.69	46.07	.00	.00	.00	.00
JUNCTION SO	179	2.78	7.01	.00	.00	.00	.00
KINGSVILLE PD	180	46.66	95.26	.00	.00	.00	.00
KINGSVILLE SO	180	29.80	89.72	.00	.00	.00	.00
BENJAMIN SO	181	2.80	7.29	.00	.00	.00	.00
PARIS PD	182	43.01	79.41	.00	.00	.00	.00
PARIS SO	182	5.83	12.93	.00	.00	.00	.00
LITTLEFIELD PD	183	8.87	21.94	.00	.00	.00	.00
LITTLEFIELD SO	183	4.57	11.05	.00	.00	.00	.00
OLTON PD	184	5.36	16.01	.00	.00	.00	.00
LAMPASAS DPS	185	14.55	46.07	.00	.00	.00	.00
LAMPASAS SO	185	3.84	8.95	.00	.00	.00	.00
HALLETTSVILLE SO	186	6.65	14.60	.00	.00	.00	.00
YOAKUM PD	187	7.50	20.72	.00	.00	.00	.00
CENTERVILLE SO	188	4.20	10.39	.00	.00	.00	.00
CLEVELAND PD	189	9.03	22.91	.00	.00	.00	.00
LIBERTY PD	190	16.87	33.22	.00	.00	.00	.00
LIBERTY SO	190	13.24	21.47	.00	.00	.00	.00
MEXIA PD	191	9.43	24.12	.00	.00	.00	.00
GEORGE WEST SO	192	2.64	7.39	.00	.00	.00	.00
LUBBOCK DPS	193	31.12	98.55	.00	.00	.00	.00
LUBBOCK PD	193	242.28	340.68	.00	.00	.00	.00
LUBBOCK SO	193	39.61	59.13	.00	.00	.00	.00
SLATON PD	194	10.01	23.71	.00	.00	.00	.00
TAHOKA PD	195	5.12	17.21	.00	.00	.00	.00
TAHOKA SO	195	4.03	9.94	.00	.00	.00	.00
MADISONVILLE SO	196	4.94	10.61	.00	.00	.00	.00
JEFFERSON SO	197	[illegible]	11.35	.00	.00	.00	[illegible]
BAY CITY PD	198	[illegible]	[illegible]	.00	.00	.00	.00
BAY CITY SO	198	5.06	11.58	.00	.00	.00	.00
EAGLE PASS PD	199	16.83	34.71	.00	.00	.00	.00
BRACY PD	200	8.69	22.54	.00	.00	.00	.00
BELLMEAD PD	201	13.17	27.92	.00	.00	.00	.00
BEVERLY HILLS PD	202	7.34	18.69	.00	.00	.00	.00
WACO DPS	203	.12	.38	.00	.00	.00	.00
WACO PD	203	233.95	467.27	.00	.00	.00	.00
WACO SO	203	24.76	65.09	.00	.00	.00	.00
WOODWAY PD	204	9.94	22.84	.00	.00	.00	.00
HONDO SO	205	15.69	39.76	.00	.00	2.02	7.04
MENARD SO	206	1.80	4.87	.00	.00	.00	.00
MIDLAND DPS	207	.12	.38	.00	.00	.00	.00
MIDLAND PD	207	68.40	144.61	.00	.00	.00	.00
MIDLAND SO	207	7.15	17.92	.00	.00	.00	.00
CAMERON SO	208	4.73	10.70	.00	.00	.00	.00
ROCKDALE PD	209	7.51	19.41	.00	.00	.00	.00
COLORADO CITY PD	210	9.07	22.43	.00	.00	.00	.00
COLORADO CITY SO	210	5.48	9.40	.00	.00	.00	.00
BOWIE PD	211	9.27	23.69	.00	.00	.00	.00
MONTAGUE SO	212	4.14	9.27	.00	.00	.00	.00
CONROE PD	213	23.51	42.96	.00	.00	.00	.00
CONROE SO	213	68.28	140.65	.00	.00	.00	.00
DUMAS PD	214	10.00	25.52	.00	.00	.00	.00
DAINGERFIELD SO	215	3.14	9.24	.00	.00	.00	.00
NACOGDOCHES PD	216	33.87	74.50	.00	.00	.00	.00
NACOGDOCHES SO(RO)	216	8.37	19.25	.00	.00	.00	.00
CORSICANA PD	217	25.35	60.44	.00	.00	.00	.00
CORSICANA SO	217	8.13	14.38	.00	.00	.00	.00
SWEETWATER PD	218	15.01	31.96	.00	.00	.00	.00
SWEETWATER SO	218	7.72	15.50	.00	.00	.00	.00
CORPUS CHRISTI DPS	219	22.53	[illegible]	.00	.00	.00	.00

187

Table 6-30. Texas 1985 Traffic To and From Each User Agency (Continuation 4)

CORPUS CHRISTI PD	219	319.73	459.04	.00	.00	.00	.00
CORPUS CHRISTI SO	219	30.62	71.41	.00	.00	.00	.00
ROBSTOWN PD	220	45.51	68.04	.00	.00	.00	.00
PERRYTON PD	221	10.66	24.42	.00	.00	.00	.00
PERRYTON SO	221	3.16	5.82	.00	.00	.00	.00
VEGA SO	222	2.17	5.54	.00	.00	.00	.00
ORANGE PD	223	42.95	81.61	.00	.00	.00	.00
ORANGE SO	223	32.64	74.13	.00	.00	.00	.00
MINERAL WELLS DPS	224	26.00	82.32	.00	.00	.00	.00
MINERAL WELLS OPS	224	23.40	74.09	4.33	6.50	.00	.00
CARTHAGE PD	225	7.68	21.45	.00	.00	.00	.00
WEATHERFORD PD	226	14.46	30.27	1.30	1.95	.00	.00
FARWELL SO	227	4.53	9.54	.00	.00	.00	.00
FRIONA PD	228	6.53	18.62	.00	.00	.00	.00
FORT STOCTON SO	229	2.41	6.34	.00	.00	.00	.00
AMARILLO DPS	230	.12	.38	.00	.00	.00	.00
AMARILLO PD	230	197.50	287.23	.00	.00	.00	.00
AMARILLO SO	230	236.97	326.69	.00	.00	.00	.00
CANYON SO	231	20.68	33.82	.00	.00	.00	.00
CLARKSVILLE PD	232	6.18	17.97	.00	.00	.00	.00
PECOS DPS	233	26.25	83.13	.00	.00	.00	.00
PECOS PD	233	14.15	29.89	.00	.00	.00	.00
PECOS SO	233	2.99	6.16	.00	.00	.00	.00
BIG LAKE SO	234	2.04	4.87	.00	.00	.00	.00
HEARNE PD	235	10.72	27.84	.00	.00	.00	.00
ROCKWALL PD	236	7.05	22.24	1.30	1.95	.00	.00
BALLINGER PD	237	7.32	21.32	.00	.00	.00	.00
HENDERSON PD	238	10.26	22.39	.00	.00	.00	.00
ARANSAS PASS PD	239	13.21	27.69	.00	.00	.00	.00
GREGORY PD	240	6.25	17.51	.00	.00	.00	.00
INGLESIDE PD	241	8.45	22.54	.00	.00	.00	.00
PORTLAND PD	242	14.22	29.31	.00	.00	.00	.00
SINTON SO	243	13.70	31.76	.00	.00	.00	.00
ELDORADO SO	244	1.74	5.09	.00	.00	.00	.00
SNYDER PD	245	14.91	32.38	.00	.00	.00	.00
SNYDER SO	245	4.45	9.61	.00	.00	.00	.00
STRATFORD SO	246	2.57	6.51	.00	.00	.00	.00
TYLER DPS	247	.12	.38	.00	.00	.00	.00
TYLER PD	247	108.18	191.26	.00	.00	.00	.00
TYLER SO	247	54.25	100.21	.00	.00	.00	.00
BRECKENRIDGE PD	248	10.56	29.17	.00	.00	.00	.00
STERLING CITY SO	249	5.12	15.75	.00	.00	.00	.00
ASPERMONT SO	250	2.54	6.21	.00	.00	.00	.00
TULIA PD	251	10.97	29.37	.00	.00	.00	.00
ARLINGTON PD	252	141.53	185.31	2.84	4.26	.00	.00
BEDFORD PD	253	23.56	38.97	1.20	1.79	.00	.00
COLLEYVILLE PD	254	10.72	22.95	1.01	1.51	.00	.00
CROWLEY PD	255	6.58	17.99	.97	1.45	.00	.00
DFW REG AIRPORT	258	28.56	98.45	5.29	7.93	.00	.00
EULESS PD	256	35.89	70.54	2.81	4.22	.00	.00
FORREST HILL PD	257	13.04	26.41	1.09	1.64	.00	.00
FORT WORTH COMP	258	527.30	705.86	11.97	17.95	.00	.00
FORT WORTH DPS	258	8.87	28.08	1.64	2.46	.00	.00
FORT WORTH PD	258	6.25	19.80	1.16	1.74	.00	.00
FORT WORTH SO 1	258	29.77	94.28	5.51	8.27	.00	.00
FORT WORTH SO 2	258	29.20	92.48	5.41	6.11	.00	.00
FORT WORTH SO 3	258	23.45	74.25	4.34	6.51	.00	.00
GRAPEVINE PD	259	17.03	31.90	1.20	1.79	.00	.00
HALTOM CITY PD	260	44.18	74.86	2.40	3.60	.00	.00
HURST PD	261	49.88	92.18	3.39	5.09	.00	.00
LAKE WORTH PD	262	10.45	23.61	1.09	1.64	.00	.00
NO RICHLAND HLS PD	263	34.56	65.77	2.52	3.78	.00	.00
RICHLAND HILLS PD	264	12.73	26.54	1.13	1.70	.00	.00
SOUTHLAKE PD	265	6.71	18.37	.99	1.48	.00	.00
TARRANT CO COMP	258	78.16	247.51	14.47	21.71	.00	.00
TURNPIKE THP	258	15.13	41.53	2.80	4.20	.00	.00
WHITE SETTLMNT PD	266	16.22	30.33	1.13	1.70	.00	.00
ABILENE DPS	267	20.29	64.25	.00	.00	.00	.00
ABILENE PD	267	117.44	233.82	.00	.00	.00	.00
ABILENE SO	267	9.25	19.70	.00	.00	.00	.00
SANDERSON SO	268	1.52	4.31	.00	.00	.00	.00
BROWNFIELD PD	269	17.09	40.89	.00	.00	.00	.00
BROWNFIELD SO	269	4.03	8.36	.00	.00	.00	.00
MT PLEASANT PD	270	9.92	25.18	.00	.00	.00	.00
SAN ANGELO DPS	271	31.66	100.26	.00	.00	.00	.00
SAN ANGELO PD	271	107.44	188.28	.00	.00	.00	.00
SAN ANGELO SO	271	7.61	15.89	.00	.00	.00	.00
AUSTIN DPS CONTROL	272	2.84	9.00	.00	.00	.00	.00

Table 6-30. Texas 1985 Traffic To and From Each User Agency (Continuation 5)

AUSTIN DPS DST OFF	272	.12	.38
.00 .00	.00	.00	
AUSTIN DPS ICR	272	.12	.38
.00 .00	.00	.00	
AUSTIN DPS ICR	272	.12	.38
.00 .00	.00	.00	
AUSTIN DPS INTCPT	272	21.24	67.25
.00 .00	.00	.00	
AUSTIN DPS NARC	272	.12	.38
.00 .00	.00	.00	
AUSTIN DPS RADIO	272	34.34	108.75
.00 .00	.00	.00	
AUSTIN DPS ROTR	272	10.66	33.75
.00 .00	.00	.00	
AUSTIN DPS SEND	272	23.29	73.75
.00 .00	.00	.00	
AUSTIN DPS TWX	272	37.58	119.01
.00 .00	.00	.00	
AUSTIN HEALTH DEPT	272	1.42	4.50
.00 .00	.00	.00	
AUSTIN MVIS	272	10.90	39.50
.00 .00	.00	.00	
AUSTIN P AND W	272	15.71	49.75
.00 .00	.00	.00	
AUSTIN PD	272	451.77	706.86
.00 .00	.00	.00	
AUSTIN SAFETY RESP	272	6.79	21.50
.00 .00	.00	.00	
AUSTIN SO	272	64.63	123.87
.00 .00	.00	.00	
UNIV OF TEXAS PD	272	9.95	31.50
.00 .00	.00	.00	
GILMER SO	273	9.57	19.29
.00 .00	.00	.00	
RANKIN SO	274	3.43	8.22
.00 .00	.00	.00	
UVALDE PD	275	12.45	28.18
.00 .00	.00	.00	
EL RIO DPS	276	31.45	99.61
.00 .00	.00	.00	
CANTON SO	277	19.06	52.99
.00 .00	.00	.00	
VICTORIA DPS	278	18.34	58.08
.00 .00	.00	.00	
VICTORIA PD	278	56.72	117.63
.00 .00	.00	.00	
VICTORIA SO	278	13.27	31.26
.00 .00	.00	.00	
HUNTSVILLE PD	279	32.45	69.65
.00 .00	.00	.00	
HUNTSVILLE SO	279	4.59	8.70
.00 .00	.00	.00	
HUNTSVILLE IDC	279	4.97	15.75
.00 .00	.00	.00	
HEMPSTEAD SO	280	12.76	21.73
.00 .00	.00	.00	
MONAHANS PD	281	10.39	27.99
.00 .00	.00	.00	
BRENHAM SO	282	2.02	5.39
.00 .00	.00	.00	
LAREDO PD	283	86.00	160.85
.00 .00	.00	.00	
LAREDO SO	283	12.39	35.92
.00 .00	.00	.00	
PIERCE DPS	284	19.52	61.82
.00 .00	.00	.00	
WHARTON SO	285	20.10	49.03
.00 .00	.00	.00	
SHAMROCK PD	286	6.45	19.05
.00 .00	.00	.00	
BURKBURNETT PD	287	[illegible].12	27.87
.00 .00	.00	.00	
WICHITA FALLS COMP	288	125.81	386.30
.00 .00	.00	.00	
WICHITA FALLS DPS	288	20.76	65.73
.00 .00	.00	.00	
WICHITA FALLS PD	288	9.55	30.25
.00 .00	.00	.00	
WICHITA FALLS SO	288	4.89	15.50
.00 .00	.00	.00	
VERNON PD	289	12.87	28.11
.00 .00	.00	.00	
RAYMONDVILLE SO	290	7.09	12.74
.00 .00	.00	.00	
FLORESVILLE SO	291	6.04	12.97
.00 .00	.57	.86	
KERMIT SO	292	2.53	5.13
.00 .00	.00	.00	
DECATUR SO	293	3.24	8.29
.43 .64	.00	.00	
WINNSBORO PD	294	7.69	23.02
.00 .00	.00	.00	
DENVER CITY PD	295	7.39	20.87
.00 .00	.00	.00	
GRAHAM PD	296	11.34	26.98
.00 .00	.00	.00	
GRAHAM SO	296	3.16	6.35
.00 .00	.00	.00	
OLNEY PD	297	6.23	18.03
.00 .00	.00	.00	
CRYSTAL CITY PD	298	7.88	21.40
.00 .00	.00	.00	
NCIC	0	2147.47	6800.31
.00 .00	.00	.00	
NLETS	0	102.64	325.01
.00 .00	.00	.00	
PALESTINE S.O.	[illegible]	3.67	11.63
.00 .00	.00	.00	
ANDREWS P.D.	2	6.30	19.95
.00 .00	.00	.00	
ARANSAS PASS P.D.	299	6.43	20.35
.00 .00	.00	.00	
PLEASANTON P.O.	300	5.21	16.51
.00 .00	.97	1.45	
MULESHOE S.O.	8	1.66	5.26
.00 .00	.00	.00	
BANDERA S.O.	301	1.84	5.83
.00 .00	.34	.51	
BASTROP S.O.	302	3.42	10.85
.00 .00	.00	.00	
BEEVILLE S.O.	10	2.80	8.87
.00 .00	.00	.00	
BRYAN S.O.	31	2.30	7.28
.00 .00	.00	.00	
ALPINE S.O.	33	1.28	4.04
.00 .00	.00	.00	
FALFURRIAS P.D.	34	5.79	18.35
.00 .00	.00	.00	
BROWNWOOD S.C.	35	2.93	9.27
.00 .00	.00	.00	
MARBLE FALLS S.O.	303	3.30	10.45
.00 .00	.00	.00	
LOCKHART S.O.	304	3.05	9.67
.00 .00	.00	.00	
LULING P.D.	305	5.15	16.32
.00 .00	.00	.00	
LOCKHART P.D.	304	5.28	16.73
.00 .00	.00	.00	
BAIRD S.O.	306	1.53	4.86
.00 .00	.00	.00	
PITTSBURG S.O.	307	1.79	5.67
.00 .00	.00	.00	
PITTSBURG P.D.	307	5.28	16.73
.00 .00	.00	.00	
PANHANDLE S.O.	308	2.17	6.88
.00 .00	.00	.00	
ATLANTA P.D.	309	6.30	19.95
.00 .00	.00	.00	
DIMMITT P.D.	43	5.28	16.73
.00 .00	.00	.00	
RU[illegible]S.C.	310	4.40	13.95
.00 .00	.00	.00	

189

Table 6-30. Texas 1985 Traffic To and From Each User Agency (Continuation 6)

RUSK P.O.	310	5.41	17.14	.00	.00	.00	.00
CHILDRESS S.O.	46	1.15	3.63	.00	.00	.00	.00
DRESS P.O.	46	5.67	17.95	.00	.00	.00	.00
HENRIETTA S.O.	311	1.28	4.04	.00	.00	.00	.00
COLEMAN S.O.	49	1.79	5.67	.00	.00	.00	.00
MCKINNEY S.O.	51	17.17	54.38	3.18	4.77	.00	.00
NEW BRAUNFELS S.O.	55	2.30	7.27	.00	.00	.43	.64
COMANCHE S.O.	56	2.43	7.68	.00	.00	.00	.00
GAINESVILLE S.O.	57	2.80	8.87	.00	.00	.00	.00
CROSBYTON S.O.	312	1.66	5.26	.00	.00	.00	.00
CARROLLTON P.O.	313	9.77	30.94	1.81	2.71	.00	.00
COOPER S.O.	314	1.92	6.07	.00	.00	.00	.00
CUERO P.O.	82	5.41	17.14	.00	.00	.00	.00
CARRIZO SPRS. P.O.	315	5.79	18.35	.00	.00	.00	.00
CARRIZO SPRS. S.O.	315	3.18	10.06	.00	.00	.00	.00
CISCO P.O.	316	5.79	18.35	.00	.00	.00	.00
EASTLAND S.O.	85	2.30	7.28	.00	.00	.00	.00
UNIV. TEXAS P.O.	89	7.42	23.50	.00	.00	.00	.00
EPHENVILLE S.O.	90	2.55	8.08	.00	.00	.00	.00
BONHAM S.O.	92	3.67	11.63	.00	.00	.00	.00
LA GRANGE S.O.	317	4.04	12.79	.00	.00	.00	.00
MT VERNON S.O.	318	1.92	6.07	.00	.00	.00	.00
PEARSALL P.O.	96	4.41	13.95	.00	.00	.82	1.22
RICHMOND P.O.	97	5.92	18.75	.00	.00	.00	.00
SEMINOLE P.O.	99	5.92	18.75	.00	.00	.00	.00
FREDERICKSBURG P.O.	107	5.67	17.95	.00	.00	.00	.00
GONZALES P.O.	103	5.79	18.35	.00	.00	.00	.00
PAMPU S.O.	110	1.92	6.07	.00	.00	.00	.00
ANDERSON S.O.	319	2.30	7.28	.00	.00	.00	.00
SEGUIN S.O.	117	2.18	6.91	.00	.00	.40	.61
MEMPHIS S.O.	320	1.53	4.86	.00	.00	.00	.00
SAN MARCOS S.O.	145	2.43	7.68	.00	.00	.00	.00
ATHENS S.O.	147	4.40	13.95	.00	.00	.00	.00
ALAMO P.O.	321	5.15	16.32	.00	.00	.00	.00
HILLSBORO S.O.	156	3.79	12.02	.00	.00	.00	.00
LEVELLAND S.O.	157	2.68	8.48	.00	.00	.00	.00
GRANBURG S.O.	322	2.18	6.91	.40	.61	.00	.00
SILVER SPRS S.O.	158	2.80	8.87	.00	.00	.00	.00
CROCKETT S.O.	323	3.05	9.67	.00	.00	.00	.00
CROCKETT P.O.	323	5.41	17.14	.00	.00	.00	.00
GREENVILLE S.O.	161	4.40	13.95	.00	.00	.00	.00
STINNETT S.O.	324	2.55	8.08	.00	.00	.00	.00
EDNA P.O.	164	5.67	17.95	.00	.00	.00	.00
JASPER P.O.	325	6.43	20.35	.00	.00	.00	.00
JASPER S.O.	325	10.53	33.34	.00	.00	.00	.00
GROVES P.O.	326	6.17	19.55	.00	.00	.00	.00
PORT NECHES P.O.	327	6.30	19.95	.00	.00	.00	.00
ALICE S.O.	168	2.80	8.87	.00	.00	.00	.00
CLEBURN S.O.	170	4.85	15.34	.90	1.35	.00	.00
KERRVILLE S.O.	178	2.43	7.68	.00	.00	.00	.00
LAMPASAS S.O.	185	2.30	7.28	.00	.00	.00	.00
COTULLA S.O.	328	1.92	6.07	.00	.00	.00	.00
GIDDINGS S.O.	329	2.17	6.88	.00	.00	.00	.00
GROESBECK S.O.	330	2.68	8.48	.00	.00	.00	.00
LLANO S.O.	331	2.68	8.48	.00	.00	.00	.00
EAGLE PASS S.O.	199	1.53	4.86	.00	.00	.00	.00
BRADY S.O.	200	1.53	4.86	.00	.00	.00	.00
DUMAS S.O.	214	1.66	5.26	.00	.00	.00	.00
NEWTON S.O.	332	3.18	10.06	.00	.00	.00	.00
BRIDGE CITY P.O.	333	5.79	18.35	.00	.00	.00	.00
VIDOR P.O.	334	6.80	21.54	.00	.00	.00	.00
MINERAL WELLS P.O.	224	8.52	26.97	.00	.00	.00	.00
PALO PINTO S.O.	335	1.53	4.86	.00	.00	.00	.00
CARTHAGE S.O.	225	3.05	9.67	.00	.00	.00	.00
FT. STOCKTON P.O.	229	6.55	20.75	.00	.00	.00	.00
LIVINGSTON S.O.	336	3.42	10.85	.00	.00	.00	.00
CANYON P.O.	231	6.43	20.35	.00	.00	.00	.00
CLARKSVILLE S.O.	232	3.67	11.63	.00	.00	.00	.00
REFUGIO S.O.	237	2.68	8.48	.00	.00	.00	.00
FRANKLIN S.O.	338	2.55	8.08	.00	.00	.00	.00
ROCKWALL S.O.	236	1.38	4.37	.25	.38	.00	.00
BALLINGER S.O.	237	1.79	5.67	.00	.00	.00	.00
HENDERSON S.O.	239	12.02	38.05	.00	.00	.00	.00
HEMPHILL S.O.	339	2.30	7.28	.00	.06	.00	.00

Table 6-30. Texas 1985 Traffic To and From Each User Agency (Continuation 7)

SAN AUGUSTINE S.O.	340	2.04	6.48	.00	.00	.00	.00
COLDSPRING S.O.	341	2.55	8.08	.00	.00	.00	.00
SAN SABA S.O.	342	1.92	6.07	.00	.00	.00	.00
MATHIS P.O.	343	5.61	17.95	.00	.00	.00	.00
SINTON P.O.	343	5.61	17.95	.00	.00	.00	.00
CENTER S.C.	344	11.41	36.12	.00	.00	.00	.00
RIO GRANDE CTY P.O.	345	5.79	18.35	.00	.00	.00	.00
RIO GRANDE CTY S.O.	345	11.13	35.25	.00	.00	.00	.00
BRECKENRIDGE S.O.	248	1.41	4.45	.00	.00	.00	.00
TULIA S.O.	251	1.92	6.07	.00	.00	.00	.00
BENBROOK P.O.	346	6.57	20.80	1.22	1.82	.00	.00
EVERMAN P.O.	347	5.44	17.24	1.01	1.51	.00	.00
RIVEROAKS P.O.	348	5.90	18.67	1.09	1.64	.00	.00
MT. PLEASANT S.O.	270	2.43	7.68	.00	.00	.00	.00
GROVETON S.O.	349	2.43	7.68	.00	.00	.00	.00
WOODVILLE S.O.	350	3.42	10.85	.00	.00	.00	.00
GILMER P.O.	273	6.30	19.95	.00	.00	.00	.00
UVALDE S.C.	275	2.93	9.27	.00	.00	.00	.00
DEL RIO P.O.	276	15.61	49.43	.00	.00	.00	.00
DEL RIO S.C.	276	2.55	8.08	.00	.00	.00	.00
MONAHANS P.O.	281	6.55	20.75	.00	.00	.00	.00
BRENHAM P.O.	282	6.80	21.54	.00	.00	.00	.00
EL CAMPO P.O.	351	6.43	20.35	.00	.00	.00	.00
WHARTON P.O.	285	6.68	21.14	.00	.00	.00	.00
WHEELER S.O.	352	2.04	6.48	.00	.00	.00	.00
IOWA PARK P.O.	353	6.05	19.15	.00	.00	.00	.00
VERNON S.C.	289	1.79	5.67	.00	.00	.00	.00
RAYMONDVILLE P.O.	290	6.43	20.36	.00	.00	.00	.00
GEORGETOWN S.O.	354	2.27	7.18	.00	.00	.00	.00
GEORGETOWN P.O.	354	6.17	19.55	.00	.00	.00	.00
TAYLOR P.O.	355	6.55	20.75	.00	.00	.00	.00
KERMIT P.O.	292	6.55	20.75	.00	.00	.00	.00
QUITMAN S.O.	356	3.79	12.02	.00	.00	.00	.00
PLAINS S.O.	357	1.53	4.86	.00	.00	.00	.00
ZAPATA S.O.	358	1.92	6.07	.00	.00	.00	.00
CRYSTAL CITY S.O.	298	3.05	9.67	.00	.00	.00	.00

191

Table 6-31. Distribution of Texas 1985 Traffic by Message Type

	Number of Messages	Message Length
LIDR - In	12,100	35
- Out	11,100	300
TCIC - In	43,100	60
- Out	40,900	86
MVD - In	26,400	50
- Out	26,400	175
NCIC		
NCIC-TCIC-NCIC	26,000	50
NCIC-NCIC-TCIC	26,000	90
NCIC-TCIC-user	26,000	90
NLETS		
To LIDR	300	35
From LIDR	300	300
To MVD	1,600	50
From MVD	1,600	175
User-Other Data Base	1,300	50
NLETS-Aust-Other Data Base	1,300	50
Other Data Base-NLETS-Aust	1,300	200
Other Data Base-User	1,300	200
Adm to Texas	1,300	300
Adm from Texas	1,300	300
NLETS-Aust-Other Adm	1,300	300
Adm - In	10,200	500
- Out	10,200	500
G-Code - In	400	300
- Out	23,800	300
Dallas DB - In	3,100	50
- Out	9,900	90
San Ant. DB - In	1,300	50
- Out	1,300	90
Law Enf. CCH - In	17,877	426
- Out	17,877	459
Courts CCH - In	8,569	773
- Out	8,569	267
Corrections CCH - In	656	819
- Out	656	221
SJIS - In	1,942	1,920
- Out	1,942	80
OBSCIS - In	6,475	242
- Out	6,475	512
L.E. Fingerprints - In	2,892	1,852
- Out	2,892	279
Texas Youth Council - In	853	280
- Out	853	512

192

Table 6-31. Distribution of Texas 1985 Traffic by Message Type (Continuation 1)

B.P.P. CCH - In	656	813
- Out	656	227
ICR Conv. - In	3,000	376
- Out	3,000	344
	396,900	

SECTION 7

NETWORK ANALYSIS AND DESIGN TOOLS

This section describes the principal network and analysis design tools developed and utilized during the STACOM Project.

Section 7.1 discusses the Network Topology Program. Section 7.2 develops the approach to network reliability and availability analysis. Sample calculations are presented for the Ohio LEADS and Texas TLETS systems. Section 7.3 derives the approach to network queueing analysis that leads to the development of network response time analysis techniques. Sample calculations are also given.

7.1 THE STACOM NETWORK TOPOLOGY PROGRAM

Two types of analysis are involved in designing a communication network. The first is concerned with arriving at acceptable line loadings; the second involves the achievement of optimal (least cost) line configurations. The STACOM program has been developed to accomplish both types of analysis.

Before describing the STACOM program itself, we will examine a state criminal justice information system and its communication network as an example of a typical communication network. We will then discuss the goal of the STACOM program.

7.1.1 State Criminal Justice Information System

An information system is usually developed to provide a systematic exchange of information between a group of organizations. The information system is used to accept (as inputs), store (in files or a data base) and display (as outputs) strings of symbols that are grouped in various ways. While an information system may exist without a digital computer, we will consider only systems which contain digital computers as integral parts.

Information systems can be classified in various ways for various purposes. If classification is by type of service rendered, the type of information system which serves a criminal justice community in a state can be considered as an information storage and retrieval system. This type of information system is the subject of our interest. For example, the state of Texas has an information system with data base located at Austin. The data base contains records on wanted persons, stolen vehicles, licensed drivers and stolen license plates. Also stored in a separate computer are files of the Motor Vehicle Department (MVD) which contain records on all and motor vehicles in the state.

7.1.2 State Digital Communication Network

For a given state information system, storage and retrieval of data to/from the data base can be accomplished in various ways for different user requirements. In general, the users of a state criminal justice information system are geographically distant from the central data base computer. Since fast turn-around time is a necessity for this particular user community, direct in-line access to the central data base by each criminal justice agency constitutes the most important user's requirements. In addition, it is required to quickly move message data from one agency to another at a different location. All of these goals require a data communication network. Because the computer deals only with digital data, only digital data communication networks are considered here.

A digital communication network consists mainly of a set of nodes connected by a set of links. The nodes may be computers, terminals or some type of communication control units in various locations, while the links are the communication channels providing a data path between the nodes. These channels are usually private or switched lines leased from a common carrier. A simple example of a network is given in Figure 7-1 where the links between modems are the communication lines leased from common carrier. The communication control unit in city E is used to multiplex or concentrate several lower speed terminals onto a high-speed line. The line which connects cities C, D, and others is called multidrop line which connects several terminals to the data base computer.

7.1.3 A STACOM Communication Network

For the purposes of the STACOM study, a communication network is defined as a set of system terminations connected by a set of links. Each system termination consists of one or more physical terminals or computers located at the same city.

7.1.4 Communication Network Configurations

The communication network for an information system with a central data base computer will be one of three basic network configurations: the star, the multidrop, or distributed connection. These three types are shown in Figure 7-2.

As shown in the figure, the star network consists of four direct connections, one for each system termination. Each connection is called a central link. The multidrop network has one line with two system terminations and two central links. In the distributed network shown, more than one path exists between each individual system termination and the central data base.

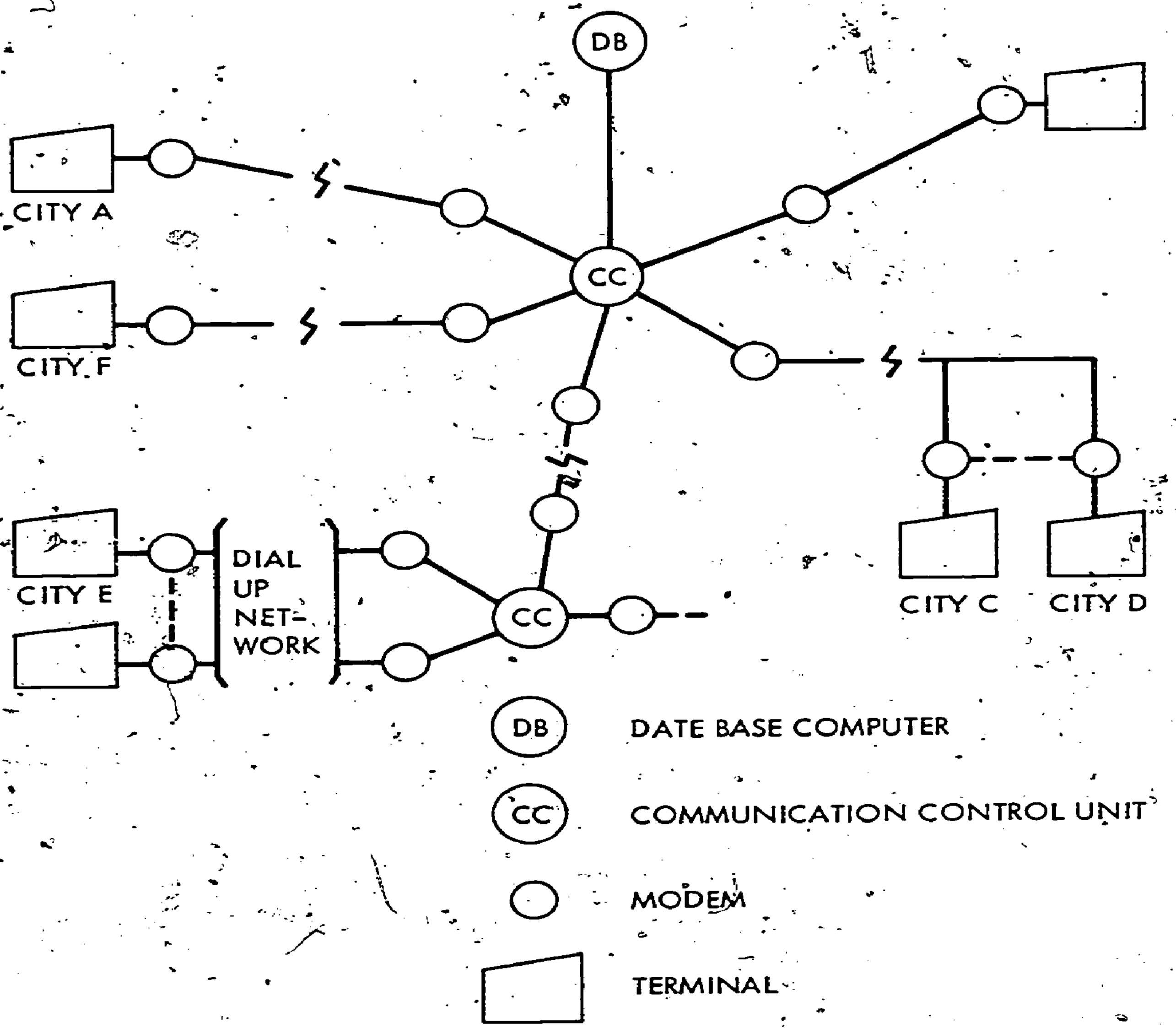


Figure 7-1. Example of a Digital Communication Network

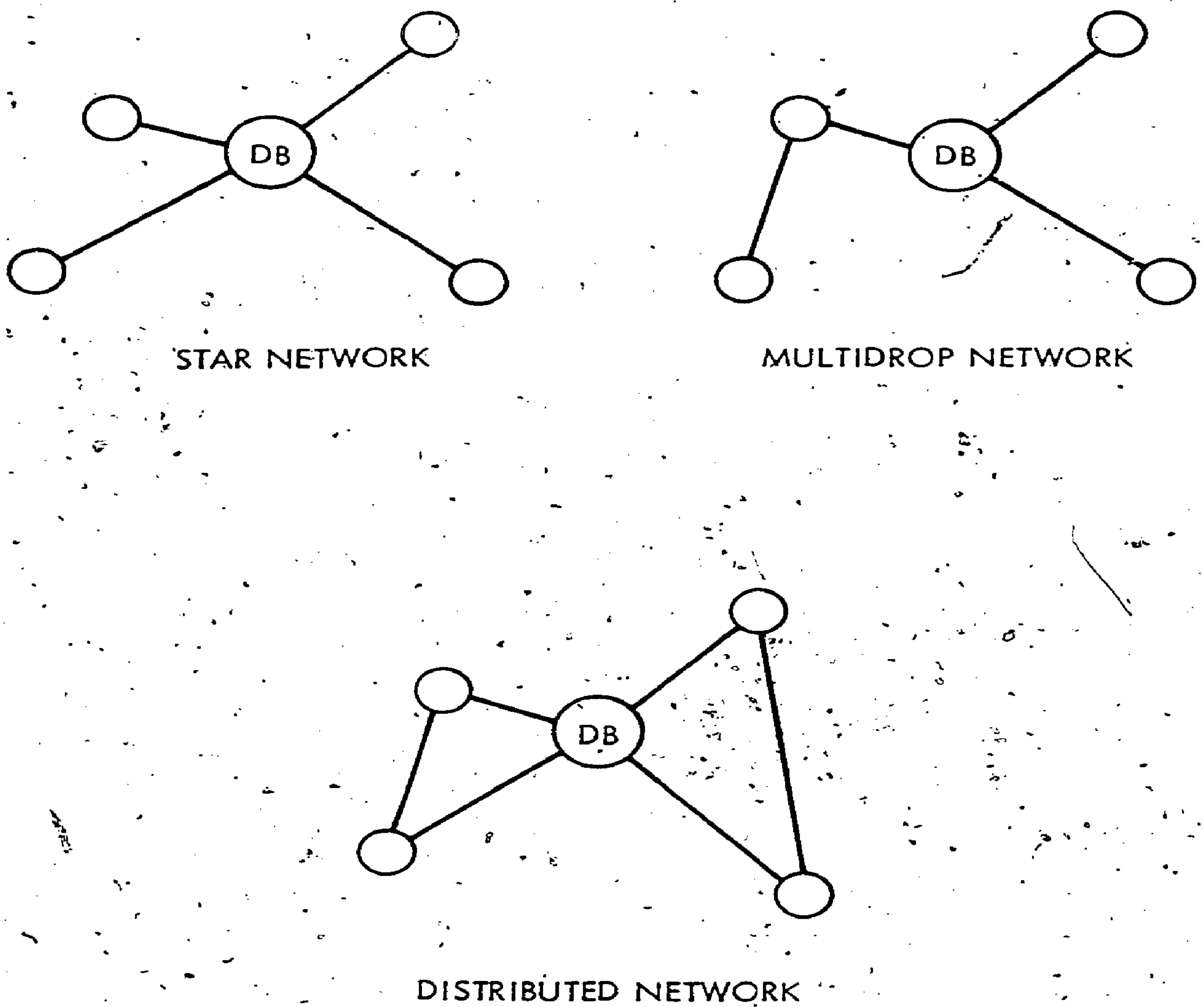


Figure 7-2. Basic Communication Network Configurations

7.1.5 Network Optimization

Given a communication network, the operating costs for the various types of lines or common carrier facilities required are governed by tariffs based upon location, circuit length and type of line. Experience suggests that the operating cost of a network can often be substantially reduced by an initial investment in a configuration analysis. In other words, some efforts in network optimization generally provide cost-saving.

There are two ways of constructing a communication network in a geometrical sense. One can divide a communication system into several regions, construct a minimum cost regional communication network for each region, and then build an inter-regional network connecting all of the regional centers to the central data base center. Each regional center is responsible for switching messages issued from and returned to each system termination in the region. Alternatively, one can consider the whole system as a region which is entirely made up of system terminations, and perform optimization for that region.

7.1.6 The STACOM Program and its Purposes

One of the objectives in the STACOM study is to design minimum cost and effective communication networks which will satisfy the predicted future traffic load for both selected model states, Ohio and Texas. In order to achieve this objective, the STACOM program was developed and utilized for the analysis and synthesis of alternative network topologies. It is also the project's goal that the final product be a portable software package which can be used as a network design tool by any user.

In network design, two major problems are the selection of a cost-effective line configuration for given traffic, and the design of a least cost network to arrive at lower operating costs.

The goal of the STACOM program is to provide a user with a systematic method for solving both problems. In other words, the main purpose of the STACOM program is to provide the network designer with a tool which he can use for line selection and for obtaining least-cost line connections.

7.1.7 Functions Performed by the STACOM Program

The STACOM program is a software tool which has been developed for the purpose of designing least cost networks in order to achieve lower operating costs. It utilizes a modified Esau-Williams technique to search for those direct links between system terminations and a regional switching center (RSC) which may be eliminated in order to reduce operating costs without impairing system performance below that specified. The RSC either provides a switching capability or is a data base center or both.

Inputs for the STACOM program contain data such as traffic, terminal locations, and functional requirements. The network may be divided into any number of desired regions in any given program run. Each region has an RSC which serves terminals in its region. RSCs are finally interconnected to form the complete network. Upon receipt of a complete set of input data, the program first performs formations of regions and, if needed, selection of RSCs. The program then builds a regional network in which only system terminations in the region are connected. The program then optimizes the regional network for each region requested by the user.

The formation of regions is performed by the program on the basis of attempting to arrive at near equal amounts of traffic for all regions. After finding the farthest unassigned system termination from the system centroid (a geographical center), the program starts formation of the first region by selecting unassigned system terminations close to this system termination until the total amount of traffic for that region is greater than a certain percentage (90% in this implementation) of the average regional traffic. The average regional traffic is simply the total network traffic divided by the number of desired regions. The same process is repeated by the program in forming the rest of the regions.

The selection of an RSC is based on the minimal traffic-distance product sum. In the selection process, each system termination is chosen as a trial RSC and the sum of traffic-distance products is then calculated. The location of the system termination which provides the minimal sum is then selected as the RSC. The location of the RSC for a given region may also be specified by the user. The optimization process consists of two basic steps, i.e., searching for lines whose elimination yields the best cost saving, and updating of the network. The two steps are repeated until no further saving is possible.

Before performing network optimization, the STACOM program constructs an initial star network in which each system termination is directly connected to the regional center. It then starts the optimization process. At the termination of this process, a multidrop network is generally developed. In a multidrop network, some lines have more than one system termination; these are called multidrop lines.

When needed, the STACOM program will continue to form an interregion network, which consists of a set of regional centers and has a direct link between any two region centers. The program then performs optimization on the network.

The process for interregional network optimization involves the same two steps: searching and updating. However, the searching step is primarily for finding an alternate route to divert traffic between two regional switching centers with the best saving.

Based on the data provided, a successful run of the STACOM program generates a regional printer output and, if requested, a CalComp plot. The printer output contains data such as initial regional network and optimized network, assignments of system terminations, etc. The CalComp plot shows the geographical connections of the optimized network in which multidrop line actually connects all of the system terminations.

Figure 7-3 gives examples of regional star networks and initial inter-regional network; Figure 7-4 gives examples of optimized regional networks and inter-regional network obtained from Figure 7-3.

7.1.8 Main Features

As described in Paragraph 7.1, the STACOM program has been developed for the purpose of performing analysis and synthesis of alternative network topologies. The following is a list of features which characterize the STACOM program:

(1) The Esau-Williams routine has been modified, tested, and utilized for determining near optimal (least cost), network topology.

(2) A tree type structure is used as the storage structure in the program.

(3) The program execution has been made flexible; for example, constraint on response time for a multidrop line is an input parameter.

(4) A response-time algorithm has been implemented in the program.

(5) A CalComp plotting routine has been included for drawing resulting multidropped networks.

In the rest of this subsection, these main features are discussed in detail.

7.1.8.1 Structure

7.1.8.1.1 Storage. Since a multidrop network can be viewed as a tree composed of sub-trees, it was determined that a tree-type data structure would be appropriate and convenient for representing a multidrop network.

A tree-type storage structure is therefore needed in the program. This tree-type storage structure is implemented by defining a set of storage cells.

Each system termination (data) is represented internally by a storage cell in the program. Each cell consists of five fields and each field occupies one word (i.e., a 36-bit word for UNIVAC 1108 computers).

200

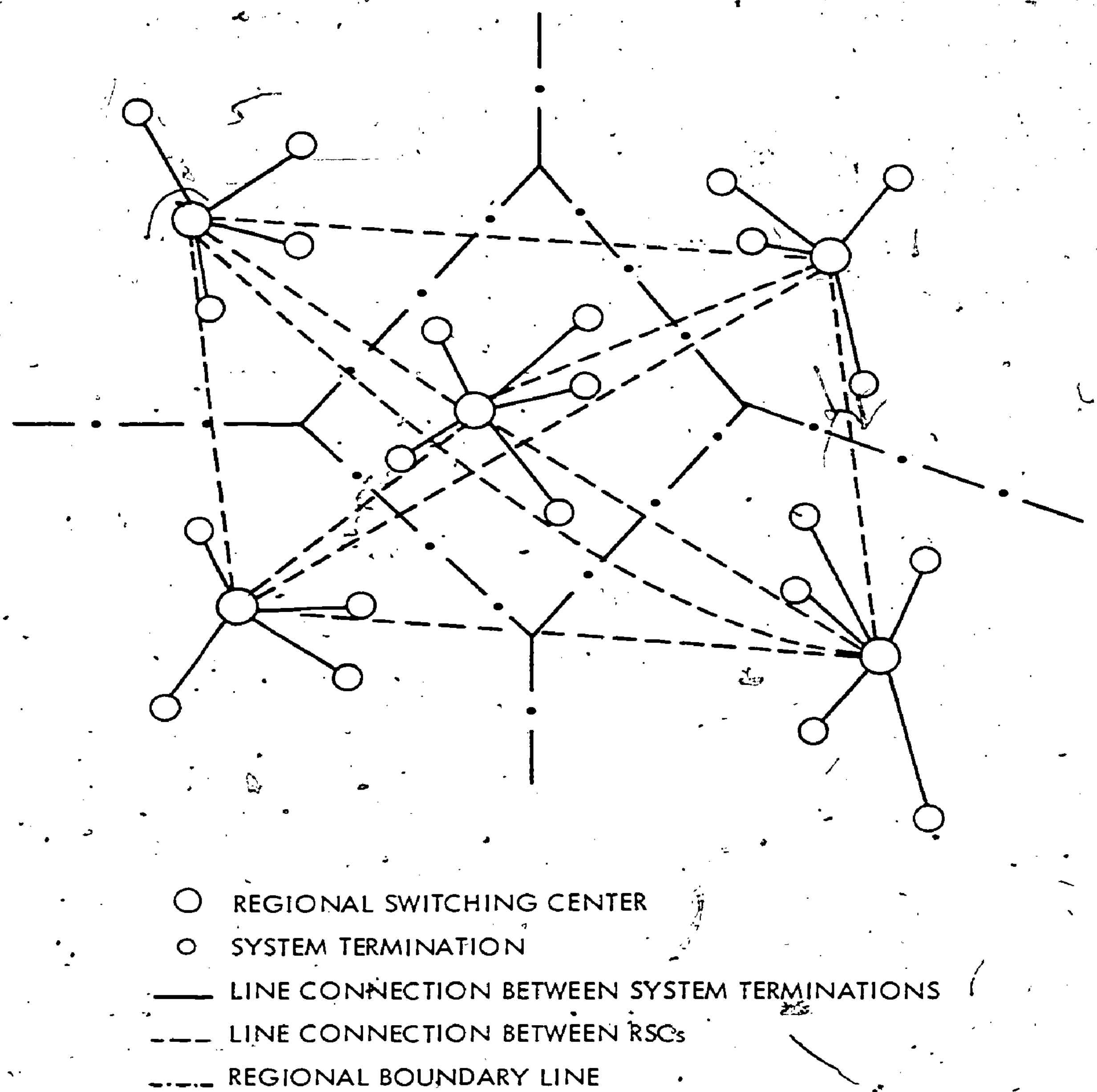


Figure 7-3. Example of Initial Region Network and Initial Interregion Network

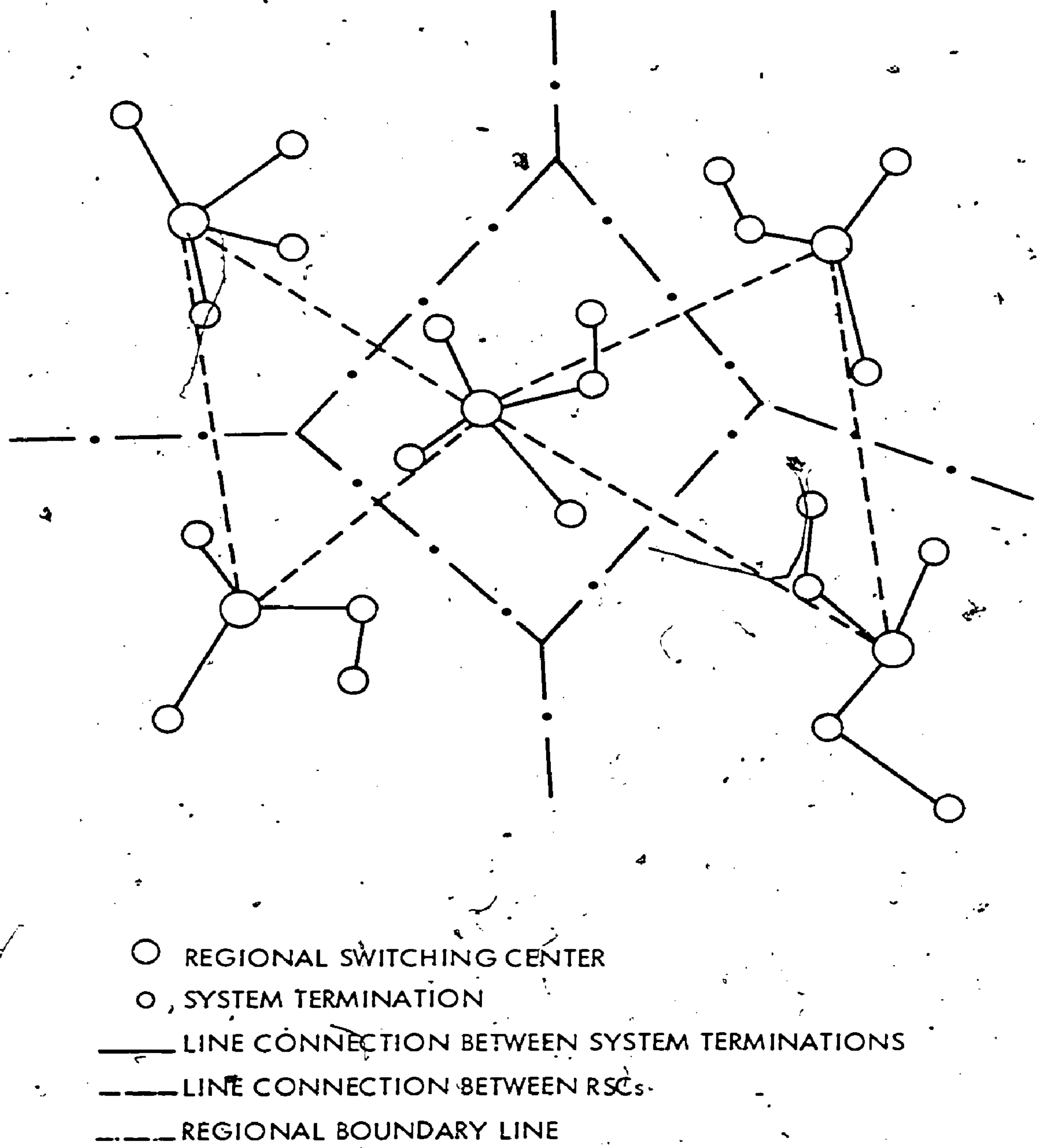


Figure 7-4. Example of Optimized Regional Networks and Optimized Interregion Network

Defining that system termination X as a successor of Y, and Y a predecessor of X if X branches out from Y, and defining X as the root of a tree if it has no predecessor before it, then the basic storage cell for system termination A can be described as follows:

I_A

A				
f_1	f_2	f_3	f_4	f_5

Let $c(f_i)$ = content of i-th field in a storage cell I_A, where I_A is an internal index of a system termination A (data), then

$c(f_1)$ = no. of system terminations under A

$c(f_2)$ = a pointer which points to the first successor of A

$c(f_3)$ = a pointer which points to the next system termination whose predecessor is the same as A's

$c(f_4)$ = a pointer which points back to the previous system termination whose predecessor is the same as A's

$c(f_5)$ = a pointer which points to A's predecessor

When there is a "zero" in a field, this indicates there is no one relating to A under that specific relationship. Given a tree as Figure 7-5, A is root of the tree; it has 4 descendents, i.e., B, C, D, and E. Figure 7-6 is the internal representation of that relationship among indice I_A, I_B, I_C, I_D and I_E which are internal cardinal numbers for system terminations A, B, C, D and E.

The first field of storage cell I_A indicates that there are 4 system terminations under I_A; the pointer to I_B says that I_B is its first successor. Since I_A is the root of the tree, the other three fields are left with zeroes.

In the case of I_C, I_D is its next successor of I_A, and its previous successor of I_A is I_B. Its third field has a pointer pointing to I_D, and its fourth field a pointer pointing to I_B.

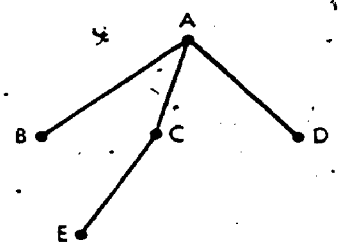


Figure 7-5. A Tree with A as its Root

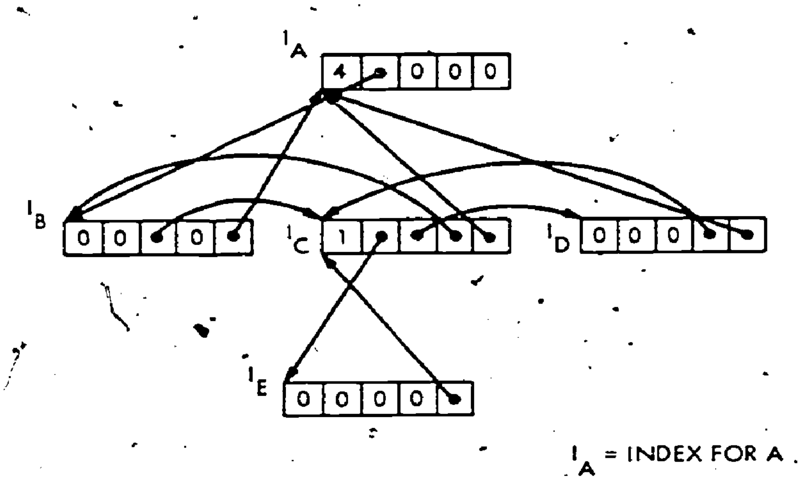


Figure 7-6. Internal Representation of the Tree in Figure 7.5

7.1.8.1.2 <u>Program</u>. The STACOM program consists of twelve functionally independent routines. Figure 7-7 shows the ~~basic~~ structure of the program. The functional interrelationship is indicated by arrows.

An arrow from routine A to routine B indicates that routine B will be called upon by routine A during its execution. In addition, all of these routines communicate to each other through the COMMON block besides the normal subroutine arguments.

Major functions of these eleven routines are given below:

(1) MAIN Routine
This is the master routine of the STACOM program. In its execution, it reads in all the data required from an input device (card reader or demand terminal) and performs calculations of distances between any two system terminations. It assigns system terminations to

204

regions, and, if necessary, selects the regional switching center by finding the system termination in the region with the minimal traffic-distance product sum. It calls upon routine RGNNET to build a star network and then performs network optimization, if required, for each of these regions.

It also performs the construction of an inter-regional network and its optimization by calling subroutine IRNOP.

In addition to these processings, the MAIN routine also prints out distance matrix, traffic matrix, and lists of system terminations by region.

(2) RGNNET Routine
This routine is called upon to act only by the MAIN routine. Its main functions are the formation and optimization of regional star networks. During the formation of a regional star network, each system termination is linked directly to the designated or selected Regional Switching Center (RSC) by assigning the RSC index to the last field of each associated storage cell. Tree relationships are built among system terminations by assigning pointers to the third and fourth fields of each storage cell. The resulting star network is then printed on the printer.

The optimization process utilizes the Esau-Williams algorithm with some modifications. It consists of two steps: searching for a central link (a direct link from a system termination to RSC) with best cost savings under constraints (such as response-time requirement), and subsequent network updating. This network optimization process is executed only upon request. When no further cost improvement is possible, this routine prints a resulting network with data such as number of system terminations and the response time, traffic, cost, etc., associated with each multidrop line. Routine PLOTPT is then called upon to plot the resulting network layout.

(3) IRNOP Routine
This routine is called upon to act by routine MAIN. It forms an interregional network and then performs its optimization. The interregional lines are assumed to be full-duplex lines. During the optimization process, no line between two RSCs can be eliminated if traffic between them cannot be handled through only one intermediate RSC. Also each RSC requires at least two lines to other RSCs.

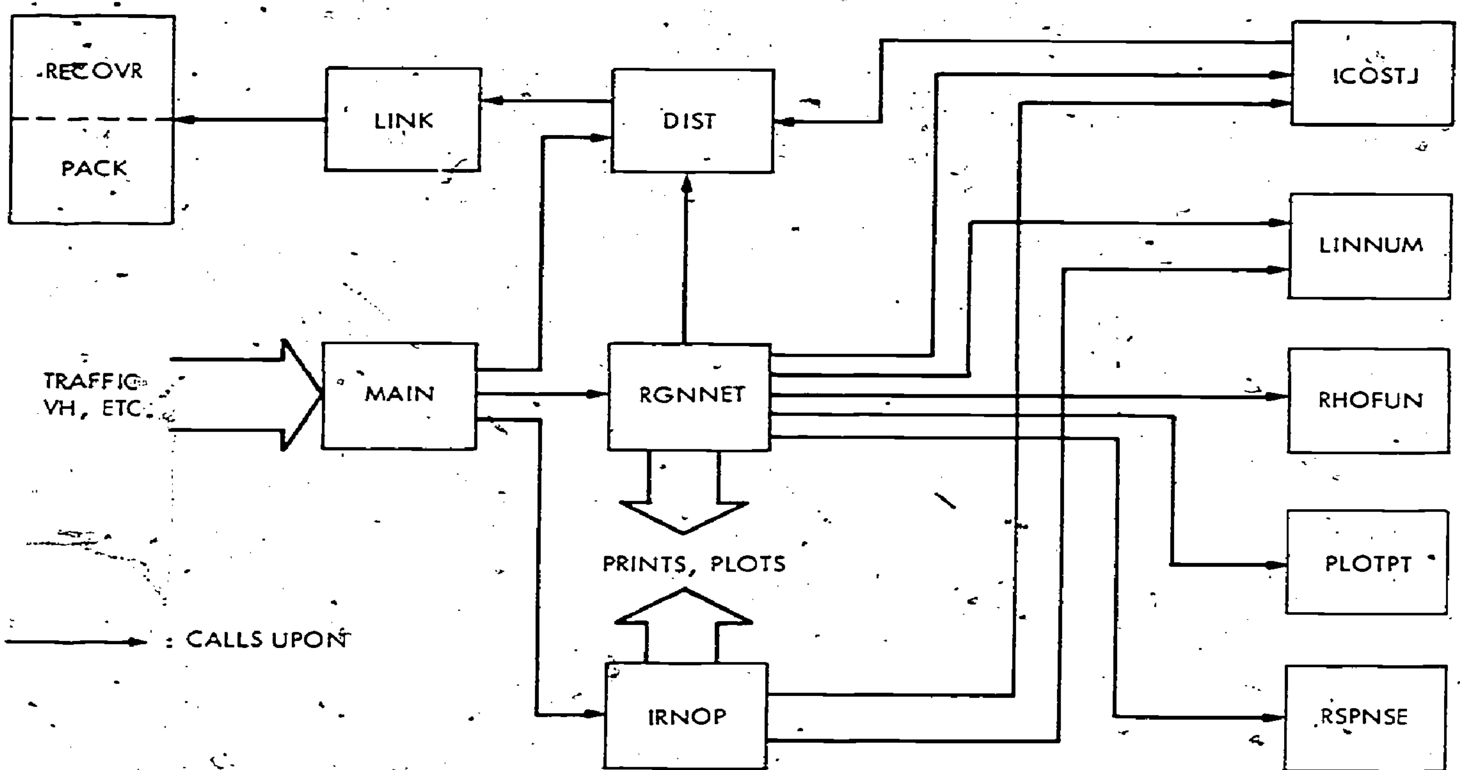


Figure 7-7. STACOM Program Structure

(4) LINNUM Routine
This routine provides an estimated line configuration required to satisfy a given traffic and is mainly called upon by routine RGNNET. During its execution, utilization of selected lines are calculated against the given traffic by calling RHOFUN so that effective line utilization is less than the pre-determined number.

(5) RHOFUN Routine
This routine calculates the line effective utilization for a given traffic and line configuration.

(6) ICOSTJ Routine
Given the line configuration and indices for any two system terminations, this routine calculates the installation costs and annual recurring costs for the line and other chargeable items required. In calculating line costs, it calls upon routine DIST for distance data between two given system terminations. Resulting cost data are arranged by chargeable item type.

(7) DIST Routine
This routine retrieves distance data between any two system terminations by calling routine PACK. When the distance is greater than 510 miles, it retrieves distance data by calling routine RECOVR.

(8) PACK Routine
This routine stores or retrieves distance data between any two system terminations. It is called upon by routine MAIN for distance data depositing, and called upon by routine DIST for its retrieval. For the purpose of saving storage, distance data has been compressed, and each 36-bit word has been divided into four sub-words of 9 bits. Therefore, any distance datum with value equal to or greater than 511 is stored in another specified area; its retrieval calls upon routine RECOVR.

(9) RECOVR Routine
During distance data retrieval in the execution of the DIST routine, if the return value from routine PACK is 511, this routine will be called upon to provide the actual distance data, which is equal to or greater than 511.

(10) LINK Routine
Since the distance between any two system terminations I and J is independent of how I and J are referred to, the routine LINK provides a mechanism for preserving such an independency by mapping I and J into an absolute index.

(11) PLOTPT Routine
This routine provides instructions for plotting a given point on a CalComp plotter. Location of a point is calculated by its associated V-H coordinates.

7.1.9 Response Time Algorithm — RSPNSE Routine

There is a limit on the number of terminals which can be linked together by a multidropped line due to constraints on reliability and response time. However, it would be an oversimplification to just use a particular number as the main constraint in determining how many terminals a multidrop line can have. In reality, the response time of a given multidrop line depends on the amount of traffic, the number of terminals on the line, and very heavily, on the number of transactions to be processed in the data base computer system.

In the STACOM program, a response time algorithm is implemented in such a way that during the network optimization process it is used to accept or reject the addition of a given terminal to a multidrop line. This response time routine calculates the average response time on the given multidrop line, given the number of terminals and amount of peak traffic on the line. Before its inclusion in the STACOM program, the fidelity of this algorithm was evaluated by simulation and found to be acceptable.

7.1.10 Flexibility

At the outset of the STACOM project it was anticipated that the STACOM program would be used for states with varying traffic requirements; it was decided that the resulting program should be as flexible and general as possible. With this in mind, the STACOM program has been implemented with the following features which make it flexible and thereby enhance its capabilities:

(1) Rate Structures, Line Types, and Chargeable Items

Because a state can have more than one rate structure (tariff) applicable at any one time, the STACOM program has been designed to accommodate this.

Under a specific rate structure, any combination of line types with their names, line capacities, and basic cost figures can be prescribed to the program. In addition to the line cost, any number of chargeable items associated with each line type can be prescribed to the program. For example, any combination of cost items such as service terminals, drops, modem and others can be used. Furthermore, under the Multischedule Private Line (MPL) tariffs given by AT&T for interstate communication lines, the monthly line charge between any two terminals is now a function of both the inter-city distance and the traffic densities of both terminal cities.

The STACOM program has been implemented in such a way that it can take line-cost figures based on ~~MPL tariffs~~ or other tariffs.

(2) Region Formation, Switcher Selection, and Network Optimization.

Given a set of system terminations dividing them into regions can be performed in either of the following ways: the user can preassign some or all of the terminations into preselected regions, alternatively the user can let the program perform the region formation by simply providing the system centroid. Following the formation process, the STACOM program will start selecting regional switching centers for regions without a preassigned switching center. The process of regional network formation and its optimization will then follow.

(3) Number of Terminals per Multidrop Line and Average Response Time

It may be desirable to set a limit on the number of terminals on a multidrop line. In its implementation, the STACOM program takes this number from the user's input data as a constraint during its optimization process.

Besides the limit on the number of terminals allowed on a multidrop line, a good network design also requires a constraint on the average terminal response time on a multidrop line. The STACOM program allows a user to specify the limit on a run basis.

7.1.11 Programming Language

The STACOM program is implemented with the FORTRAN V language of UNIVAC systems, compiled with the EXEC-8 FORTRAN Preprocessor and mapped by its MAP processor.

7.1.12 Operating System Requirements

The EXEC-8 operating system of the UNIVAC 1108 computer has been used in the development of the STACOM program. The current edition of the STACOM program can only be executed under the EXEC-8 system. Furthermore, since a CalComp routine is linked with the program, the plotter must be part of the operating system. If such a hardware unit is not included in the system, the STACOM program must be updated to reflect this environment.

In addition, the current STACOM program has been designed with the feature that all the desired output be put into a FORTRAN file designated as 100. Before executing this program, a file with the name 100 must be assigned. Otherwise, regular WRITE unit 6 will be the destination output file, e.g., print output will go to the user's demand terminal when it is run as a demand job.

As an example, the following is a complete list of EXEC-8 control statements which need to be prepared or typed in after the run card for properly executing the STACOM program.

```
@ASG,UP 100
@SYM,P PUNCH$,,G9PLTF
@XQT File.Element
    S
  (data)
    S
@BRKPT 100
@FREE  100
@SYM   100,,T4
```

The @SYM,P command directs the resulting plot card images to a CalComp plotter designated G9PLTF. The last @SYM command directs print output to the slow hardcopy printer designated T4.

7.1.13 Functional Limitations

While the STACOM program has been designed and implemented with the intention that it be applicable as widely as possible, it does have certain limitations. These are due mainly to the limit of program size (sum of I and D bank) allowed under the EXEC-8 system for simplistic programs. The maximum program size allowed is 65k words per program. Although it is more convenient for later use to assign all parameters with maximum values as long as the overall program size is within limits, this results in greater expense in later use of the program due to the higher core-time product. Therefore, it is recommended that all parameters be set at values just high enough for anticipated use.

After setting parameter values, the STACOM program capabilities are then limited to these assigned values. If a run requires that certain parameter value be exceeded, the STACOM program must be recompiled and remapped.

7.2 SYSTEM RELIABILITY AND AVAILABILITY ANALYSIS

While cost may be a major concern in deciding the option for network implementation when several alternatives are available, the factor of system reliability (survival probability) and availability as a function of alternate option does deserve some considerations. The reliability and availability of a system not only depends on how the system is built up, it also depends on how each component of the system behaves as time passes by. In the following sections, we will present assumptions and definitions of terms and equations which are to be used later in calculating system reliabilities and availabilities. The constraints of subsystems to be investigated and results from applying these equations for both Ohio and Texas are then presented.

7.2.1 Assumptions

The true reliability (survival probability) of a given component as a function of age is impossible to describe exactly and simply. However, in many cases, a component's reliability can be practically and usefully represented as a unit with a "bathtub" shape failure rate function as shown in Figure 7-8. In other words, a component can be well described as having a failure rate that is initially decreasing during the infant mortality phase, constant during the so-called "useful life" phase, and, finally, increasing during the so-called "wear-out" phase.

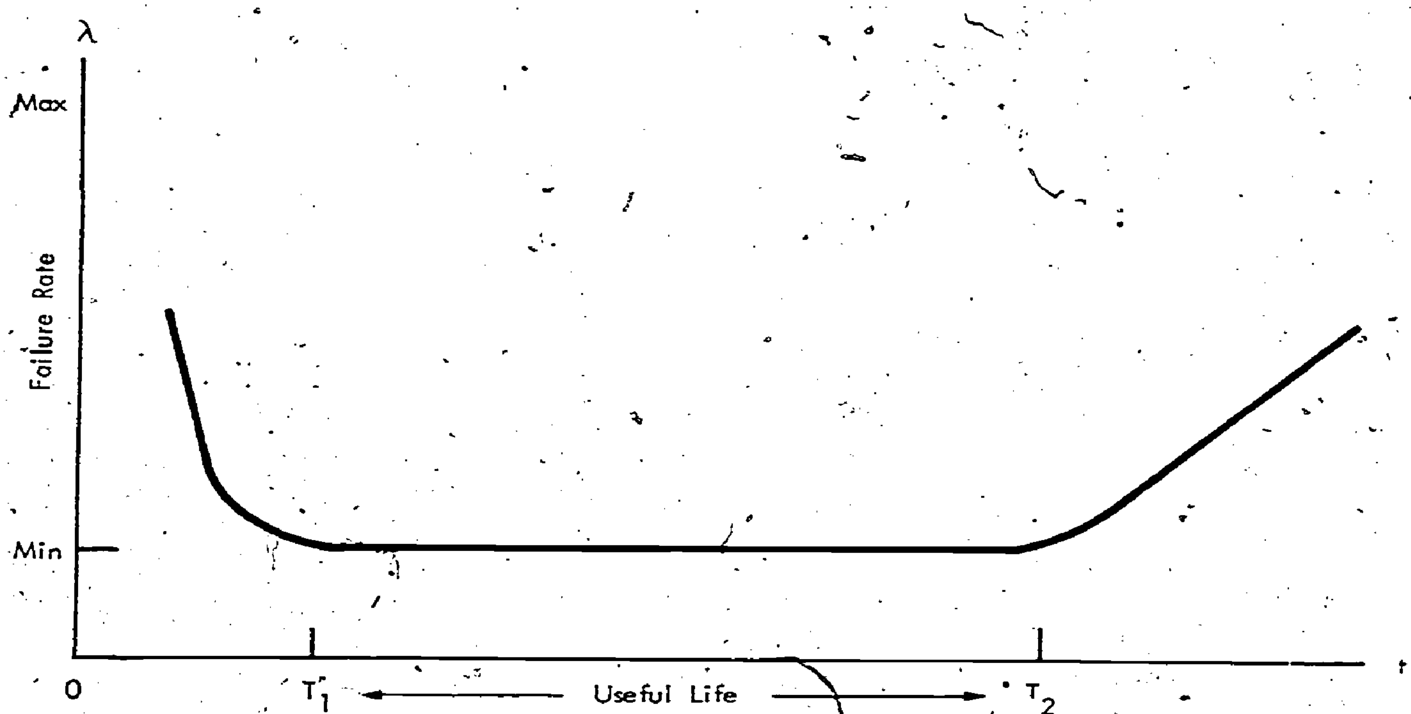


Figure 7-8. "Bathtub" Failure Rate Function

211

In this study, we assume that all components are to be operated within the constant failure rate phase. Several distribution functions do have such a constant failure rate case. However, in the following discussions, we use the exponential distribution to represent the reliability function for each individual component. An important property of the exponential distribution is that the remaining life of a used component is independent of its initial age (the "memoryless property"). With the exponential distribution it follows that:

(a) Since a used component is as good as new (statistically), there is no advantage in following a policy of planned replacement of used components known to be still functioning.

(b) The statistical estimation data of mean-life, percentiles, reliability and so on, may be collected on the basis only of the number of hours of observed life and of the number of observed failures; the ages of components under observation are irrelevant.

7.2.2 Definition

For the purpose of convenience in later discussions, we give definitions to the following terms and notations:

(a) λ_i = Failure rate for component i

(b) μ_i = Mean time between failures (MTBF) for component i

(c) ν_i = Mean time to repair (MTTR) for component i

(d) R(t) = Reliability function as a function of time, t

(e) A(t) = Availability function as a function of time, t

(f) A_{av} = The limiting average availability

(g) $\gamma_i = \nu_i/\mu_i$

(h) λ = System failure rate

(i) μ = System MTBF

(j) ν = System MTTR

212

7.2.3 System Reliability and Availability

Given a system with n (≥ 2) components, it is in general impossible to derive its exact reliability and availability. However, if the statistical interrelationship among its components can be described, we can then relate the system reliability and availability to the reliabilities and availabilities of the components. For the simplest case, if all of the components are statistically independent and each of them has a constant failure rate λ_i, then the overall system reliability R(t) for a series system (a system which functions if and only if each component functions) is

$$R(t) = e^{-\lambda t} \tag{1}$$

where $\lambda = \sum_{i=1}^{n} \lambda_i$

n = number of components in the system

If the system has a parallel structure (a system which functions if and only if at least one component functions), its reliability becomes

$$R(t) = 1 - \prod_{i=1}^{n} \left(1 - e^{-\lambda_i t}\right) \tag{2}$$

where Π denotes the multiplication operation.

Furthermore, for a series system, its limiting average system availability can be described as

$$A_{avg} = \left(1 + \sum_{i=1}^{n} \gamma_i\right)^{-1} \tag{3}$$

and the average of system downtime (MTTR) becomes

$$\nu = \mu \sum_{i=1}^{n} \gamma_i \tag{4}$$

where μ = system MTBF

$$= \left(\sum_{i=1}^{n} 1/\mu_i\right)^{-1} = \left(\sum_{i=1}^{n} \lambda_i\right)^{-1} \tag{5}$$

7.2.4 System Reliability and Availability for the Texas Network

7.2.4.1 Reliability System Structures. The existing communication network for Texas consists of two central data base computers at Austin, one central switcher at Austin and two regional switching computers at both Dallas and San Antonio.

With this in mind, the reliability system structures for an individual user terminal can be described as follows:

Case 1: User Terminal - Austin Switcher - Austin Data Base Computer

Figure 7-9 shows the reliability system structure for the user terminal when its communication with the central data bases has to go through the Austin switcher only.

Since line L_2 is a very short one and it is an in-house line, its reliability is considered to be 1. This also applies to the following cases.

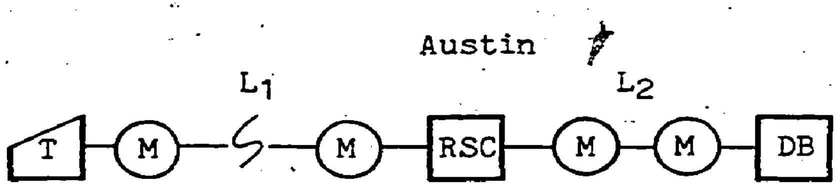


Figure 7-9. Texas Reliability Structure for Case 1

Case 2: User Terminal - Dallas Switcher - Austin Switcher - Austin Data Base Computer

Figure 7-10 shows the reliability system structure for the user terminal when its communication with the data base has to go through both Dallas and Austin switchers.

(c) Case 3: User Terminal - San Antonio Switcher - Austin Switcher - Austin Data Base Computer

Case 3 is similar to Case 2, with the exception that San Antonio switcher is the local switcher instead of Dallas switcher. It is shown in Figure 7-11.

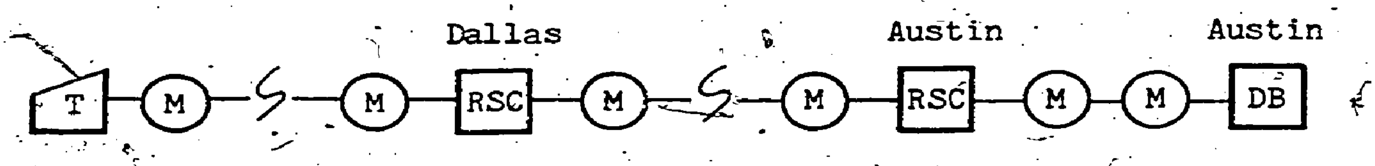


Figure 7-10. Texas Reliability Structure for Case 2

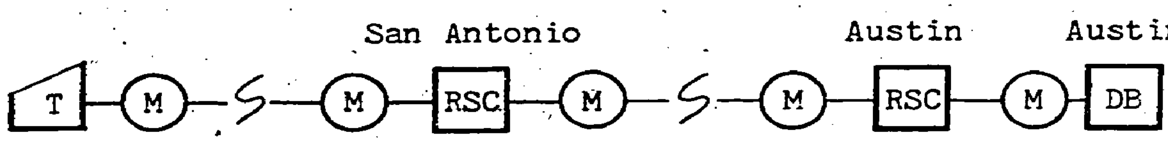


Figure 7-11. Texas Reliability Structure for Case 3

7.2.4.2 Empirical Components' Failure Statistics. Table 7-1 shows failure statistics for all of relevant components as given in Texas reliability system structures. These data are provided by different sources as indicated on the Table.

7.2.4.3 System Reliabilities and Availabilities.

(a) Case 1

The effective system failure rate is equal to

$$\lambda_1 = \lambda_T + 4\lambda_M + \lambda_L + \lambda_{RSC} + \lambda_{DB} + \lambda_{ENV}$$
$$= 0.02786$$

Its reliability function as a function of time becomes

$$R_1(t) = e^{-0.02786t}$$

Applying

$$t = 24, \; R_1(24) = 0.512$$

Since $\lambda_1 = \lambda_T + 4\lambda_M + \lambda_L + \lambda_{RSC} + \lambda_{DB} + \lambda_{ENV}$

$$= 0.0832$$

and its average availability is equal to

$$A_1 = 0.9134.$$

Given a 24-hour operation period, the system will have a sum of 110.6 minutes of outage. These results are tabulated in Table 7-2.

Table 7-1. Empirical/Estimate Components' Failure Statistics

	Component	μ_i MTBF	ν_i MTTR	λ_i Failure Rate ($X10^{-3}$)	A_i Availability	γ_i	Source
1.	Terminal	900	0.667	1.11	0.99926	.074	Int. Comm. Corp.
2.	Modem	5000	3	0.2	0.9994	0.6	Ohio WU
3.	Line	668.5	1.4	1.496	0.099791	2.1	Ohio WU
4.	Data Base Environment	350.8	0.57	2.85	0.9984	1.62	Ohio
5.	Austin S/W	143.9	1.17	6.94	0.9920	8.13	↑
6.	Dallas S/W	145.0	0.95	6.89	0.9935	6.53	Texas
7.	San Antonio S/W	145.4	0.56	6.88	0.9962	3.86	DPS
8.	Data Base	68.3	4.67	14.64	0.936	68.4	↓

(b) Case 2

The effective system failure rate is equal to

$$\lambda_2 = \lambda_1 + 2\lambda_M + \lambda_L + \lambda_{RSC} \text{ at Dallas}$$
$$= 0.03664$$

and its reliability function becomes

$$R_2(t) = e^{-0.03664t}$$

Applying $t = 24$, $R_2(24) = 0.415$

Since $\gamma_2 = 0.0930$, its average system availability is equal to

$$A_2 = 0.915$$

Given a 24-hour operational period, the system will have a sum of 122.5 minutes of outage. These results are tabulated in Table 7-2.

Table 7-2. Texas System Reliabilities and Availabilities for a 24-Hour Operation Period

	System 1	System 2	System 3
1) Reliability	0.512	0.415	0.415
2) Availability	0.9232	0.915	0.917
3) Daily Outage	110.6 minutes	122.5 minutes	119.3 minutes

(c) Case 3

The effective system failure rate is equal to

$$\lambda_3 = \lambda_1 + 2\lambda_M + \lambda_L + \lambda_{RSC} \text{ \underline{at San Antonio}}$$

$$= 0.03663$$

and its reliability function becomes

$$R_3(t) = e^{-0.03663}$$

Applying $t = 24$, $R_3(24) = 0.415$

Since $\gamma_3 = 0.09036$

its average system availability is equal to

$$A_3 = 0.917$$

Given a 24-hour operation period, the system will have a sum of 119.3 minutes of outage. These results are also tabulated in Table 7-2.

7.3 RESPONSE TIME ALGORITHM

This section describes a network response time algorithm which models mean response time values at network user terminals. Response time is defined as that time interval between the time a network user initiates a request for network service and the time at which a response is completed at the users inquiring terminal.

Section 7.3.1 describes a general approach to network response time modeling. Following this background material, specific models used in Texas are discussed in Sections 7.3.2.

7.3.1 General Response Time Modeling Approach

7.3.1.1 Approach. Components of the model described in this section can be assembled to mimic response time behavior at any terminal imbedded in any network configuration incorporating terminals, lines, message switching computers and data base computers.

To facilitate discussion, we shall consider the components for a response time model for the general network depicted in Figure 7-12, although the principles of model component development apply to any network configuration.

In the network shown, Regional Switching Computers, (RSCs), service terminals within their defined regions. RSCs from each region are connected to a central RSC which provides a data base for inquiry/response transactions.

The longest response time at a system termination will occur on a multi-dropped line served by a remote RSC. The response time model discussed here treats this condition.

Figure 7-13 presents a simplified drawing of the configuration of interest. The remote RSC services a multidrop of M terminals and receives a single regional traffic load from all other terminals in the region. In our discussion, intraregion lines are half duplex and interregion lines are full duplex. Again, the general approach is not limited to these specific choices.

The central RSC connected to the data base receives traffic from the remote RSC of interest, and from both terminals in its region, and other RSCs in the network.

In this scheme, messages transmitted from multidrop terminals to the data base and back to the appropriate multidrop terminal, encounter a series of queues.

The total time spent in any queue is defined as the time spent waiting for service from a facility plus the time spent by the facility in servicing the transaction. The response time model developed here considers average or mean values for all variables, so that,

$$E(\text{Queue Time}) = E(\text{Wait Time}) + E(\text{Service Time})$$

Facilities in the model consist of transmission lines and computers.

Figure 7-14 shows seven distinct queues encountered by a data base inquiry and response operation from a multidropped terminal. The wait time and service time components of each queue are delineated in the figure. Inquiry input to the data base moves across the top of the figure from left to right. Response output from the data base moves across the bottom of the figure from right to left. Each of the queues, seven in all, are numbered for later easy reference when specific equations are discussed.

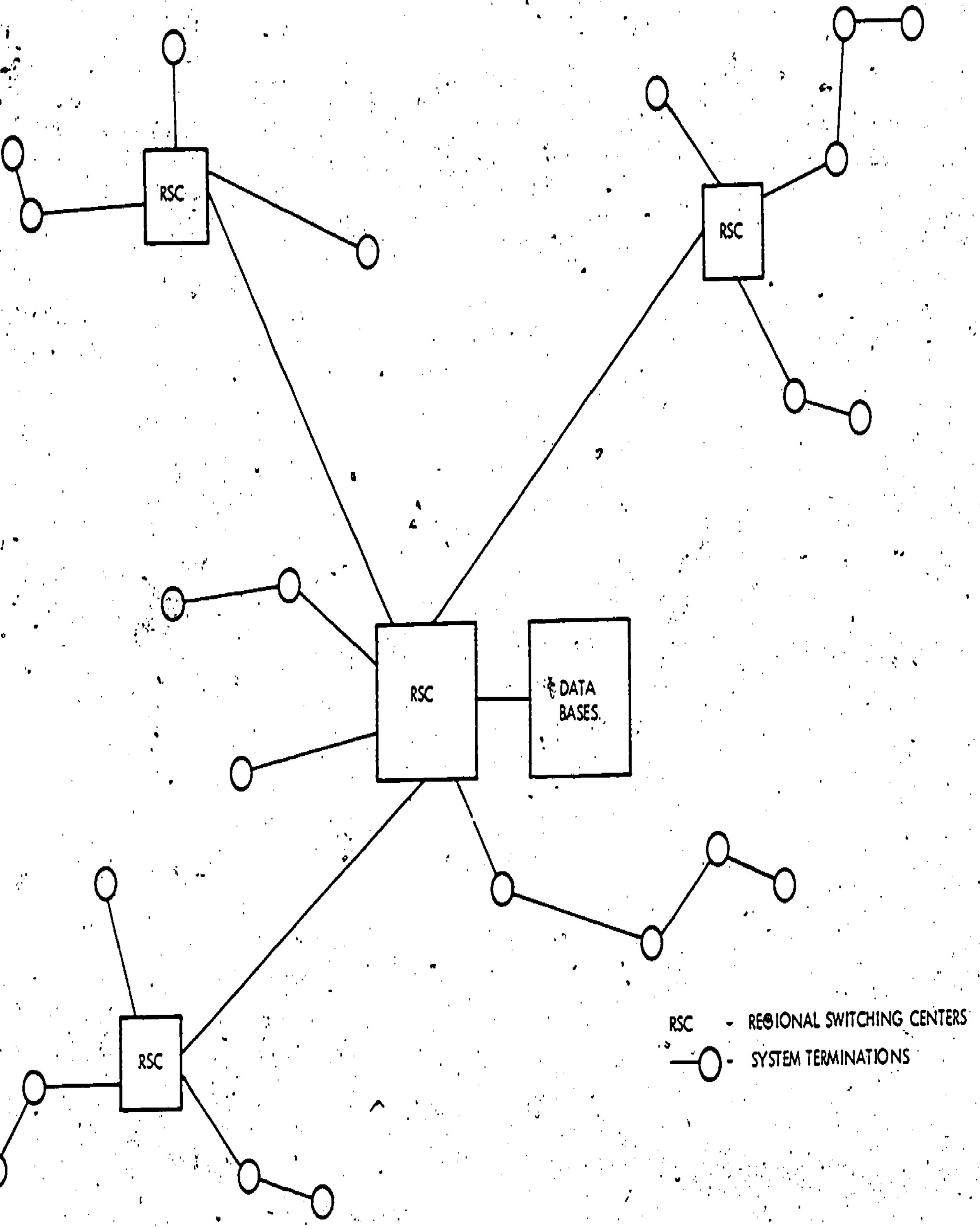


Figure 7-12. A General Network

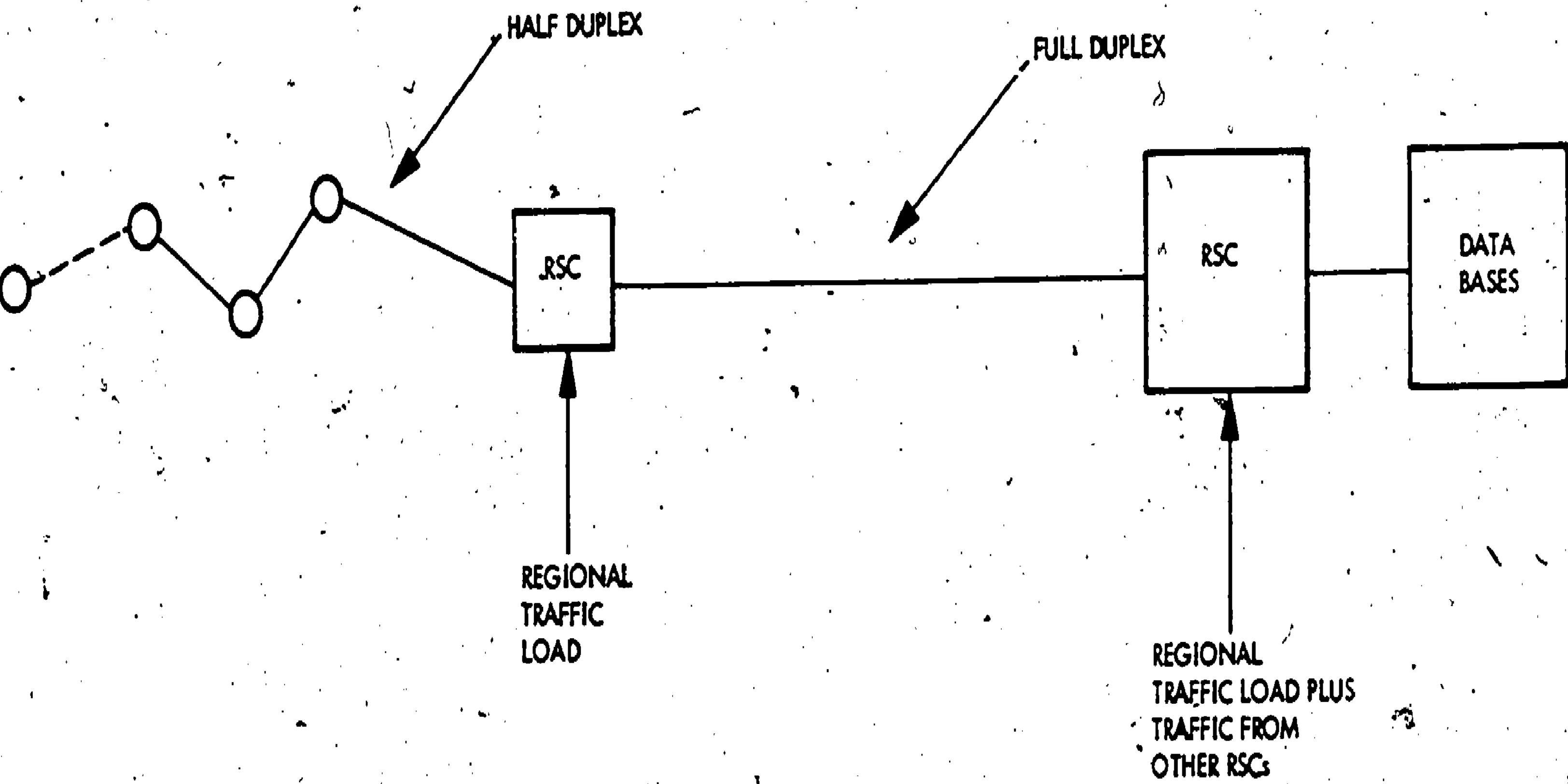


Figure 7-13. Simplified Configuration For Response Time Analysis

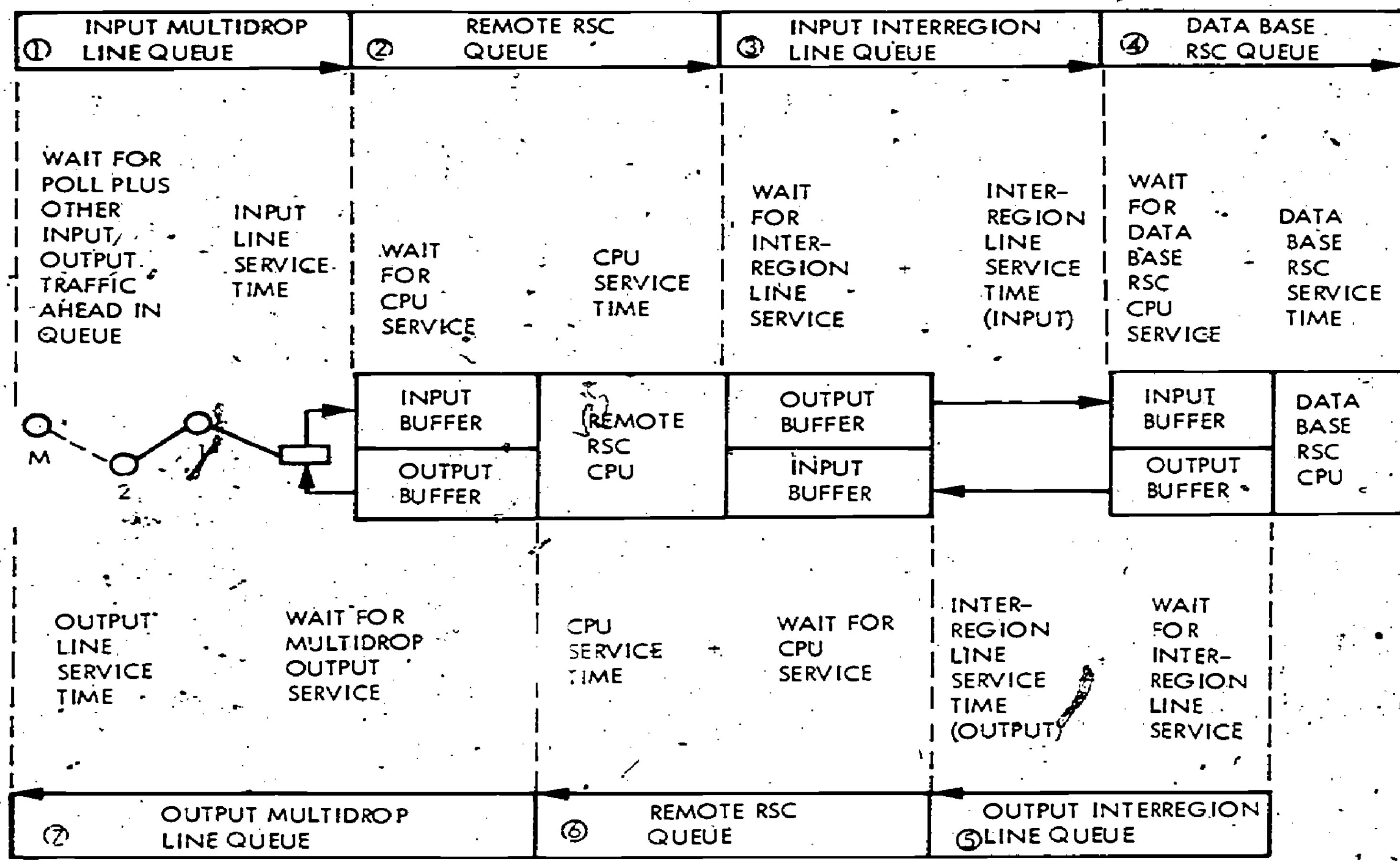


Figure 7-14. System Message Queues

Each of the queues is considered to be a single server queue, with the exception of the data base RSC computer which may be treated as a double server queue (dual CPUs) if desired.

7.3.1.2 General Equations. We shall now develop a set of general equations for a response time model. In this model, response time is defined as that time from initiation of a request for network service at a terminal to the time that a response is completed at the requesting terminal. We wish to develop equations for the queues outlined in Figure 7-14 for a network capable of handling three types of message priorities. In addition, for purposes of this discussion, output from the computer onto the multidrop line is given priority over input messages to the computer from the multidrop line.

Thus, there are really 4 types of priorities to deal with. Consider the three message priority types as being

Priority 1 = Message type A
Priority 2 = Message type B
Priority 3 = Message type C

Then, on the multidrop, the model will need to handle the following four priority types

Priority 1 = Output of Message type A
Priority 2 = Output of Message type B
Priority 3 = Output of Message type C
Priority 4 = Input of all Message types

This approach is necessary since messages cannot be prioritized until they reach a computer, at which point, message types can be examined and appropriate priorities assigned to each. It is assumed here that it is not desirable to allow network users to assign priorities to messages.

On interregion full duplex lines, output does not interfere with input so that the model need deal with input and output of the three priority types, messages A, B, and C only.

The following assumptions are made for model development:

(1) Traffic arrival patterns at facilities are Poisson.

(2) Inter-arrival times of messages are exponentially distributed.

(3) Output messages from the computer to the multidrop line have priority over input messages from the terminals to the computer.

(4) Message dispatching is first in, first out, (FIFO).

(5) No messages leave queues without first being serviced.

(6) Polling is cyclic on the multidrop with equal weighting for each terminal.

(7) Message handling is on a non pre-emptive basis, that is, messages are not interrupted once they are placed on a transmission line.

(8) When dual CPU's are considered, they are assumed to be evenly loaded.

(9) Users on the multidrop line do not hold the line for more than one message before polling is resumed.

Under conditions of the above assumptions, the mean waiting time, E(tw), in a single server queue is

$$E(tw) = \frac{\rho E(ts)}{1 - \rho} \tag{1}$$

where E(ts) = mean service time (sec)

and $\rho = E(n) \times E(ts)$

where E(n) = average number of transaction arrivals per second

The mean queue time is therefore

$$E(tq) = E(tw) + E(ts)$$

or

$$E(tq) = \frac{\rho E(ts)}{1 - \rho} + E(ts)$$

or simplified

$$E(tq) = \frac{E(ts)}{1 - \rho} \tag{2}$$

The term, ρ, is a measure of facility utilization and is equal to the fraction of time that a facility is in use serving transactions. The term, ρ, takes on values betwen 0 and 1. When $\rho = 1$ it means that the facility is 100% utilized. We shall see that ρ values should generally not exceed 0.700.

For dual server queues, such as computers with twin processors where an incoming transaction is serviced by the first processor which is not busy, the waiting time for service, E(tw), is given by

223

$$E(tw) = \frac{\rho^2}{1 + \rho} \frac{E(ts)}{1 - \rho} \qquad (3)$$

and in this case the traffic value, E(n), should be halved in calculating ρ; that is

$$\rho = \frac{E(n)}{2} E(ts)$$

Before presenting specific equations for the queues outlined in Figure 7-14, we shall consider the general equations for waiting times when it is desired to handle messages of different priority types.

The ability to prioritize messages can be an important network feature when there is a mixture of long and short messages on the network, that is, when there is a wide range of average message lengths for different message types. For example, in the law enforcement environment, when long message types such as digital fingerprint data, Computerized Criminal History data, digital facsimile data or long administrative messages are included in a network along with shorter inquiry/response messages related to officer safety, it may be expedient to transmit the latter message types with a higher priority over the network to insure shorter response times for these more important message types.

The response time model is capable of handling up to four message priority levels. The mean wait time components of mean queue times for the four priority levels are given below. Priority 1 is the highest priority.

Mean wait time, Priority 1,

$$E(tw1) = \frac{\rho E(ts)}{1 - \rho_1} \qquad (4)$$

Mean wait time, Priority 2,

$$E(tw2) = \frac{\rho E(ts)}{(1 - \rho_1).(1 - \rho_1 - \rho_2)} \qquad (5)$$

Mean wait time, Priority 3,

$$E(tw3) = \frac{\rho E(ts)}{(1 - \rho_1 - \rho_2)(1 - \rho_1 - \rho_2 - \rho_3)} \qquad (6)$$

Mean wait time, Priority 4,

$$E(tw4) = \frac{\rho E(ts)}{(1 - \rho_1 - \rho_2 - \rho_3)(1 - \rho)} \qquad (7)$$

In the above equations

ρ_i = facility utilization due to priority i message type $i = 1, 2, 3, 4$

and $\rho_i = E(n_i) \times E(ts_i)$

where $E(n_i)$ = arrivals per second of priority i type messages

and $E(ts_i)$ = service time for priority i type messages

so that the total facility utilization

$$\rho = \rho_1 + \rho_2 + \rho_3 + \rho_4$$

and the total message arrivals per second

$$E(n) = E(n_1) + E(n_2) + E(n_3) + E(n_4)$$

Finally, in the model, there are two types of service times to be calculated. One is service time for message transmission over communication line facilities and the other is service time for message switching and data base acquisition by computer facilities.

For the four priority types, service times for messages on communication lines are given by

$$E(tsi) = \frac{(Lmi + OH) \times Bc}{C} + MPSE \qquad (8)$$

where $i = 1, 2, 3, 4,$

and Lmi = average message length of a priority i type message in characters

OH = number of overhead characters that accompany a message on the network

Bc = number of bits per character

C = line capacity in Bauds

MPSE = time spent for pauses in transmission due to modem line turnaround time or other factors

The unsubscripted service time term, E(ts), (which appears with the unsubscripted ρ term in the numerators of equations 4 thru 7), is calculated similarly, but uses the overall network average message length, Lm, in place of Lmi,

$$Lm = P_1(Lm1) + P_2(Lm2) + P_3(Lm3) + P_4(Lm4)$$

where P_i = the percentage of priority i type messages on the network
i = 1, 2, 3, 4

The mean service time for a negative poll on the multidrop network is given by

$$E(tPOLL) = \frac{POH \times Bc}{C_m} + PPSE \qquad (9)$$

where POH = number of polling characters including overhead characters

Bc = number of bits per character

C_m = line capacity in Bauds

PPSE = total line pauses during a negative poll due to modem turnarounds, etc. There are two line turnarounds for a negative poll on a half duplex line.

Note that communication line service times do not include terms accounting for line transmission delays as a function of distance. These contributions to total response time are negligible and are not included in the model.

Mean service times for computers are estimated from data supplied by computer system vendors. Of interest is the average time required to process a transaction. For an RSC the time is that required to perform message switching. For a remote single server RSC, the mean queue time E(tqRC), is

$$E(tqRC) = \frac{E(tsRC)}{1 - \rho_{RC}} \qquad (10)$$

where E(tsRC) = mean service time for switching per transaction in a regional computer

ρ_{RC} = facility utilization for a regional computer

and ρ_{RC} = E(nRC) E(tsRC)

where E(nRC) = total transaction arrivals per second at the regional RSC

For an RSC connected to a data base, we shall assume that the computer is a dual processor so that it behaves as a dual server queue. In this case, the mean queue time for the data base switcher computer, E(tqCD), is

$$E(tqCD) = \frac{\rho^2_{CD}}{1 + \rho_{CD}} \cdot \frac{E(tsCD)}{1 - \rho_{CD}} + E(tsCD) \qquad (11)$$

where E(tsCD) = mean service time for switching plus data base access per transaction

ρ_{CD} = facility utilization for an RSC with data base

and $\rho_{CD} = \frac{E(nCD)}{2} E(tsCD)$

where E(nCD) = total transaction arrival rate per second at the data base RSC

Mean service times for computers are hardware and software configuration dependent, which necessitates vendor consultation in each case. Generally, computer mean service times will range from 100 ms to 700 ms.

In arriving at values for computer mean service times, it is important to visualize the computer facility as a single large queue, despite the fact that the operating system may involve many queues in reality. One approach, for example, may consider the mean number of program steps executed per transaction and the mean number of disc accesses per transaction. Typical numbers may be:

ITEM	SPEED	TIME
150,000 instructions per transaction	@ 1 microsecond mean instruction execution time	0.150
6 disc accesses per transaction	@ 47.5 milliseconds per access	0.285
	MEAN COMPUTER SERVICE TIME =	0.435 sec

Ideally, vendors or system users may have actual measurements available from operating statistics.

7.3.1.3 Inputs/Outputs. The general model requires the input data listed in Table 7-3. Table 7-4 describes the terms calculated by the model. Figure 7-15 clarifies where various terms apply in the model.

Table 7-3. Model Inputs

Item	Symbol	Meaning and Units
1	Cm	Line capacity of the multidrop (Baud)
2	CR	Line capacity of interregion line (Baud)
3	OH	Overhead characters in line protocol (CH)
4	MPSEM	Total line turn-around time on multidrop (sec)
5	MPSER	Total line turn-around time on interregion line (sec)
6	M	Number of terminals on multidrop
7	UC	Units per character (bits)
8	L_1	Priority one output average message length (CH)
9	L_2	Priority two output average message length (CH)
10	L_3	Priority three output average message length (CH)
11	L_4	Input average message length (CH)
12	L_5	Priority one input average message length (CH)
13	L_6	Priority two input average message length (CH)
14	L_7	Priority three input average message length (CH)
15	Lm	Overall system average message length (CH)
16	E(nm1)	Mean arrival rate of priority one output messages to multidrop (msg/sec)
17	E(nm2)	Mean arrival rate of priority two output messages to multidrop (msg/sec)
18	E(nm3)	Mean arrival rate of Priority 3 output messages to multidrop (msg/sec)

Table 7-3. Model Inputs (Continuation 1)

Item	Symbol	Meaning and Units
19	E(nm4)	Mean arrival rate of all input messages from multidrop (msg/sec)
20	E(nRI1)	Mean arrival rate of Priority 1 input messages on interregion line (msg/sec)
21	E(nRI2)	Mean arrival rate of Priority 2 input messages on interregion line (msg/sec)
22	E(nRI3)	Mean arrival rate of Priority 3 input messages on interregion line (msg/sec)
23	E(nRO1)	Mean arrival rate of Priority 1 output messages on interregion line (msg/sec)
24	E(nRO2)	Mean arrival rate of Priority 2 output messages on interregion line (msg/sec)
25	E(nRO3)	Mean arrival rate of Priority 3 output messages on interregion line (msg/sec)
26	E(nCR)	Mean number of transactions/sec at RSC (trans/sec)
27	E(nCD)	Mean number of transactions/sec at the RSC with a data base (trans/sec)
28	E(tsCR)	Mean service time per transaction for the RSC computer (sec/trans)
29	E(tsCD)	Mean service time per transaction for the RSC data base computer (sec/trans)

229

Table 7-4. Calculated Values

Item	Symbol	Meaning and Units
1	E(tsmi) i = 1-7	Mean service time for messages on the multidrop line (sec/msg)
2	E(tsm)	Mean service time for messages on the multidrop using overall average message length (Lm) (sec/msg)
3	E(twmi) i = 1-4	Mean wait time for service on the multidrop line (sec/msg)
4	ρmi i = 1-4	Mean utilization of multidrop line for each priority type
5	ρm	Total mean utilization of multidrop line for all messages
6	E(tqCR)	Mean queue time of RSC (sec/msg)
7	E(tsRIi) i = 1-3	Mean service time for input messages on interregion line (sec/msg)
8	E(tsROi) i = 1-3	Mean service time for output messages on interregion line (sec/msg)
9	E(tsRI)	Overall mean service time for input messages on interregion line (sec/msg)
10	E(tsRO)	Overall mean service time for output messages on interregion line (sec/msg)
11	ρRIi i = 1-3	Mean utilization of interregion line for input messages for each priority type
12	ρROi i = 1-3	Mean utilization of interregion line for output messages for each priority type
13	ρRI	Total mean utilization of interregion line for all input messages.
14	ρRO	Total mean utilization of interregion line for all output messages
15	E(twRIi) i = 1-3	Mean wait time for input service on inter-regional line (sec/msg)
16	E(twROi) i = 1-3	Mean wait time for output service on inter-regional line (sec/msg)
17	E(tqCD)	Mean queue time of RSC with data base (sec/msg)

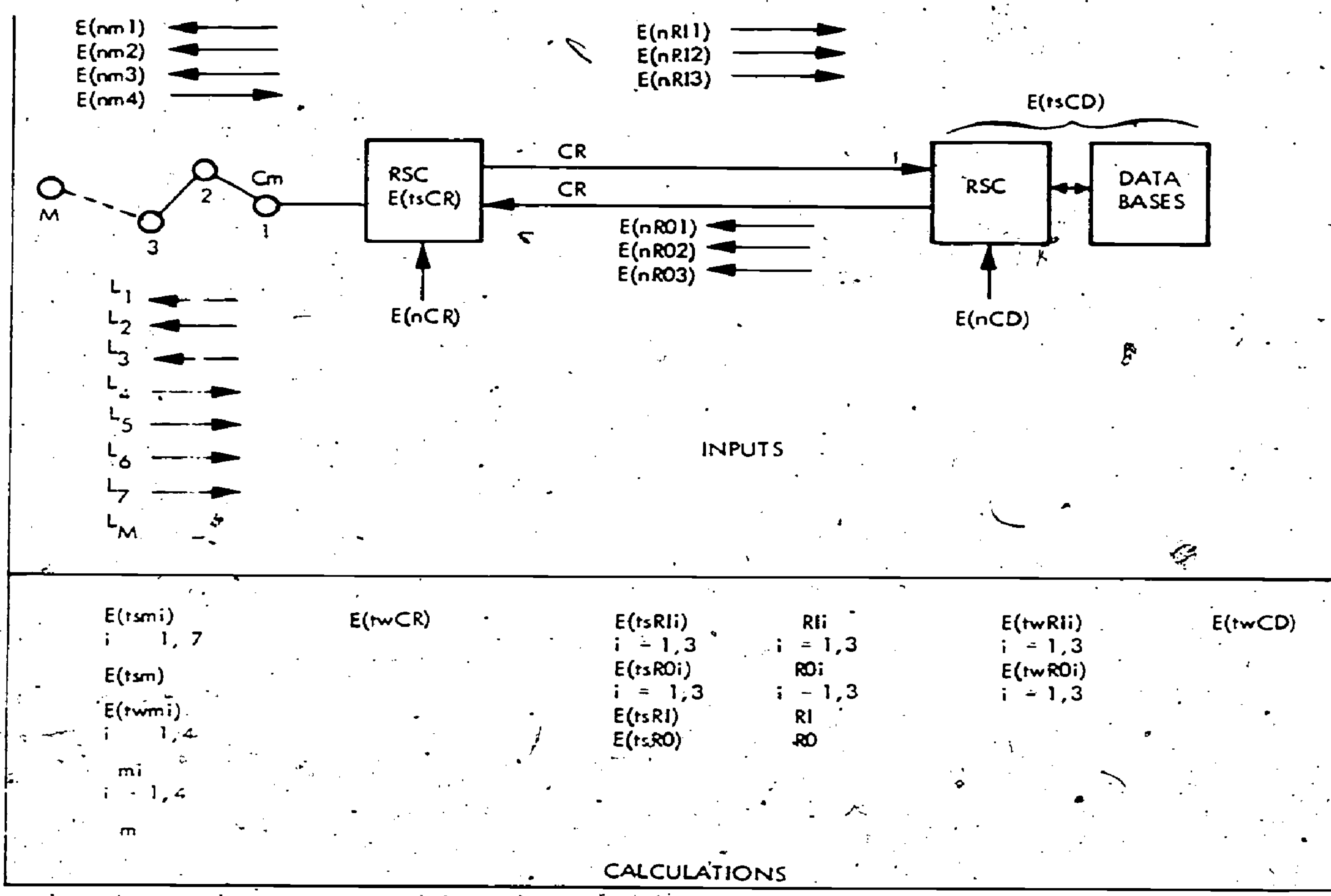


Figure 7-15. Model Inputs and Calculated Values

231

Once the calculated values are found, it is a simple matter to sum up the desired components of the seven queues involved, (outlined in Figure 7-14,) to arrive at desired values for response times by priority type. It is also possible to use the model for simpler network configurations which may or may not involve message prioritization. The following two examples will clarify model use.

EXAMPLE 1

Suppose we wished to find response times for the network shown in Figure 7-14 under the following conditions:

- There are three priority type messages on the network, A, B, and C, with A being the higher priority
- Output of messages to the multidrop line has priority over input messages from the line multidrop
- Inquiry messages flow from the multidrop line through an RSC, over interregion lines to a data base RSC and response messages flow back

The equations for response time are presented below. There are three equations shown.

E(trA) = mean response time for a priority A message

E(trB) = mean response time for a priority B message

E(trC) = mean response time for a priority C message

Each equation is comprised of the appropriate wait and service time components calculated by the model. The equation for E(trA) is presented in more detail. The equations for E(trB) and E(trC) are of similiar construction, however, the wait times in queues are longer since they are of lower priority and the line service times are different since average message lengths are different. These differences are evident in the use of different subscripts. Note that the wait time for line service for an input message on the multidrop line is the same in all equations since input from the multidrop is visualized as priority 4 on the multidrop line, that is, input waits for all output onto the multidrop.

Term	Explanation (See Table 7-4)	Queue No. (See Figure 7-14)
E(trA)	Response time of priority A messages	Not applicable
$= \left[\frac{M-1}{2}\right]E(tpoll)$	Mean waiting time for poll at a terminal	1

232

Term	Explanation (See Table 7-4)	Queue No. (See Figure 7-14)
+ E(twm4)	Mean waiting time for other input messages on multidrop that may be polled before terminal of interest.	1
+ E(tsm5)	Mean service time for Priority A input message on multidrop line	1
+ E(tqCR)	Mean queue time at RSC	2
+ E(twRI1)	Mean waiting time for Priority A message for interregion line service	3
+ E(tsRI1)	Mean service time for Priority A message on interregion line	3
+ E(tqCD)	Mean queue time at RSC with data base	4
+ E(twRO1)	Mean waiting time for Priority A message for interregion line service	5
+ E(tsRO1)	Mean service time for Priority A message on interregion line	5
+ E(tqCR)	Mean queue time at RSC	6
+ E(twM1)	Mean wait time for output service of Priority A message onto multidrop line	7
+ E(tsM1)	Mean service time for output message of Priority A on multidrop line	7

$$E(trB) = \left[\frac{M-1}{2}\right] E(tpoll) + E(twm4) + E(tsm6) + E(tqCR)$$
$$+ E(twRI2) + E(tsRI2) + E(tqCD)$$
$$+ E(twRO2) + E(tsRO2) + E(tqCR)$$
$$+ E(twm2) + E(tsm2)$$

and

$$E(trC) = \left[\frac{M-1}{2}\right] E(tpoll) + E(twm4) + E(tsm7) + E(tqCR)$$
$$+ E(twRI3) + E(tsRI3) + E(tqCD)$$
$$+ E(twRO3) + E(tsRO3) + E(tqCD)$$
$$+ E(twm3) + E(tms3)$$

EXAMPLE 2

Suppose we wish to deal with the simpler network configuration shown in Figure 7-16. As before, the longest response time in this network will occur on one of the multidropped lines. Therefore, consider the simplification of Figure 7-17 where we consider one such line. Consider, also, the following characteristics of interest.

- There is no prioritization of messages.
- Output of messages to the multidrop has priority over input messages from the multidrop
- A single RSC with data base is used in the network

Under these conditions, the response time, E(tr), for messages is given by

$$E(tr) = \left[\frac{M-1}{2}\right] E(tpoll) + E(twm2) + E(tsm2)$$

$$+ E(tqCD) + E(twm1) + E(tsm1)$$

In this equation, output is given priority one and input is given priority two.

7.3.1.4 Model Validation. The reader will note that simplifications have been introduced into the model. For example, mean queue time at computers is calculated without regard to average message lengths of transactions. This assumes that the mean number of software operations carried out per transaction (hence, mean time), as well as time for disc accesses, is fairly insensitive to the lengths of messages which are being handled. These and other simplifying assumptions are best tested by comparing model outputs with simulation. This exercise was performed with a GPSS program that simulated a network with the characteristics of Example 2 of the section entitled Model Inputs/Outputs, but with two priority message types, A and B, instead of no prioritization. Results are shown in Figure 7-18. These results show the model to be sufficiently close to simulation results to be of meaningful value as a design tool. Values used in these specific tests are shown in Table 7-5. Values in Table 7-5 for E(nCD), E(nm1), E(nm2), and E(nm3) correspond to a total network transaction level of 90,720 transactions per day. The curves of Figure 7-18 were generated by increasing, (or decreasing), these values proportionately to generate x coordinate values.

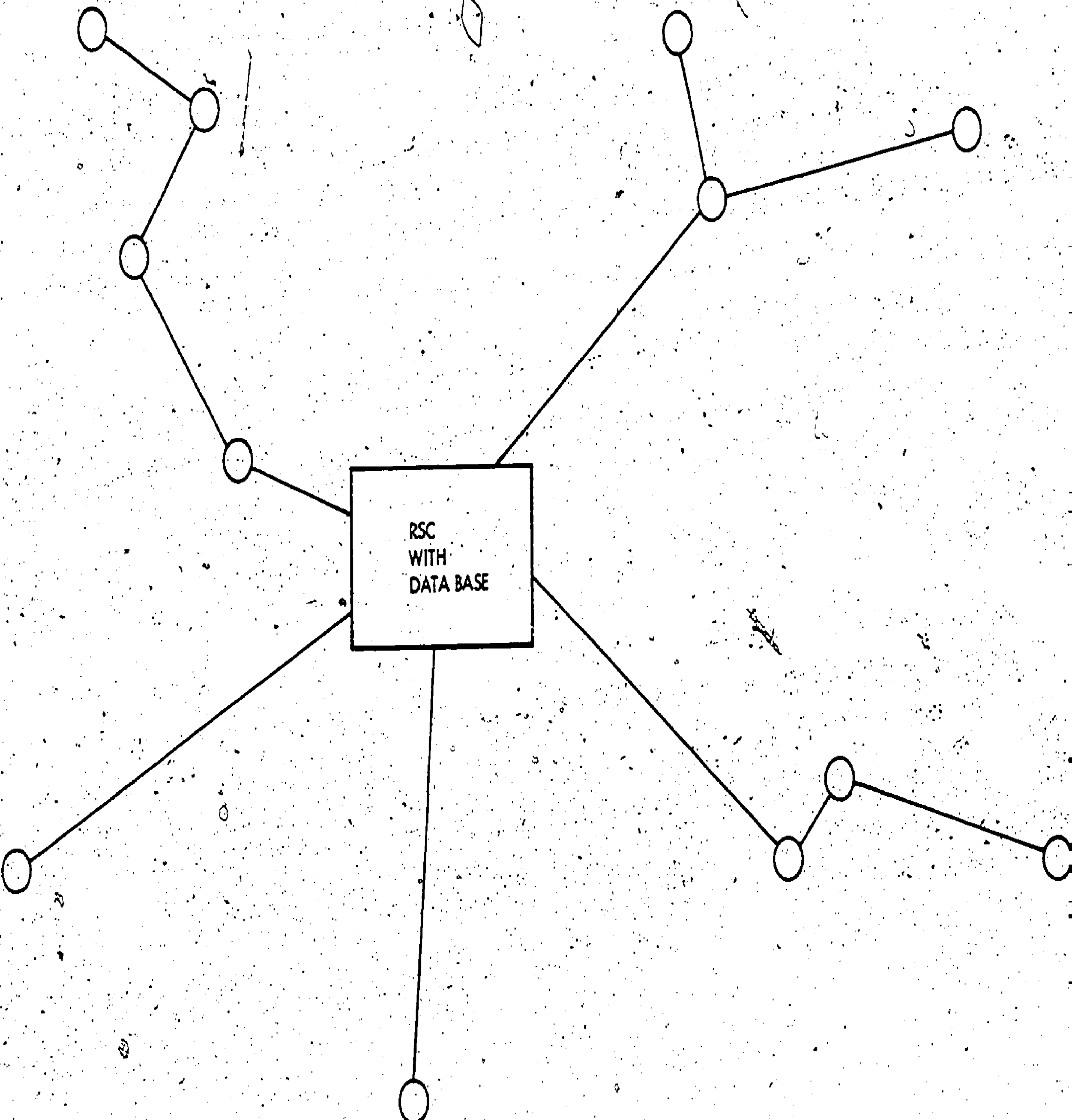


Figure 7-16. A Simpler Network

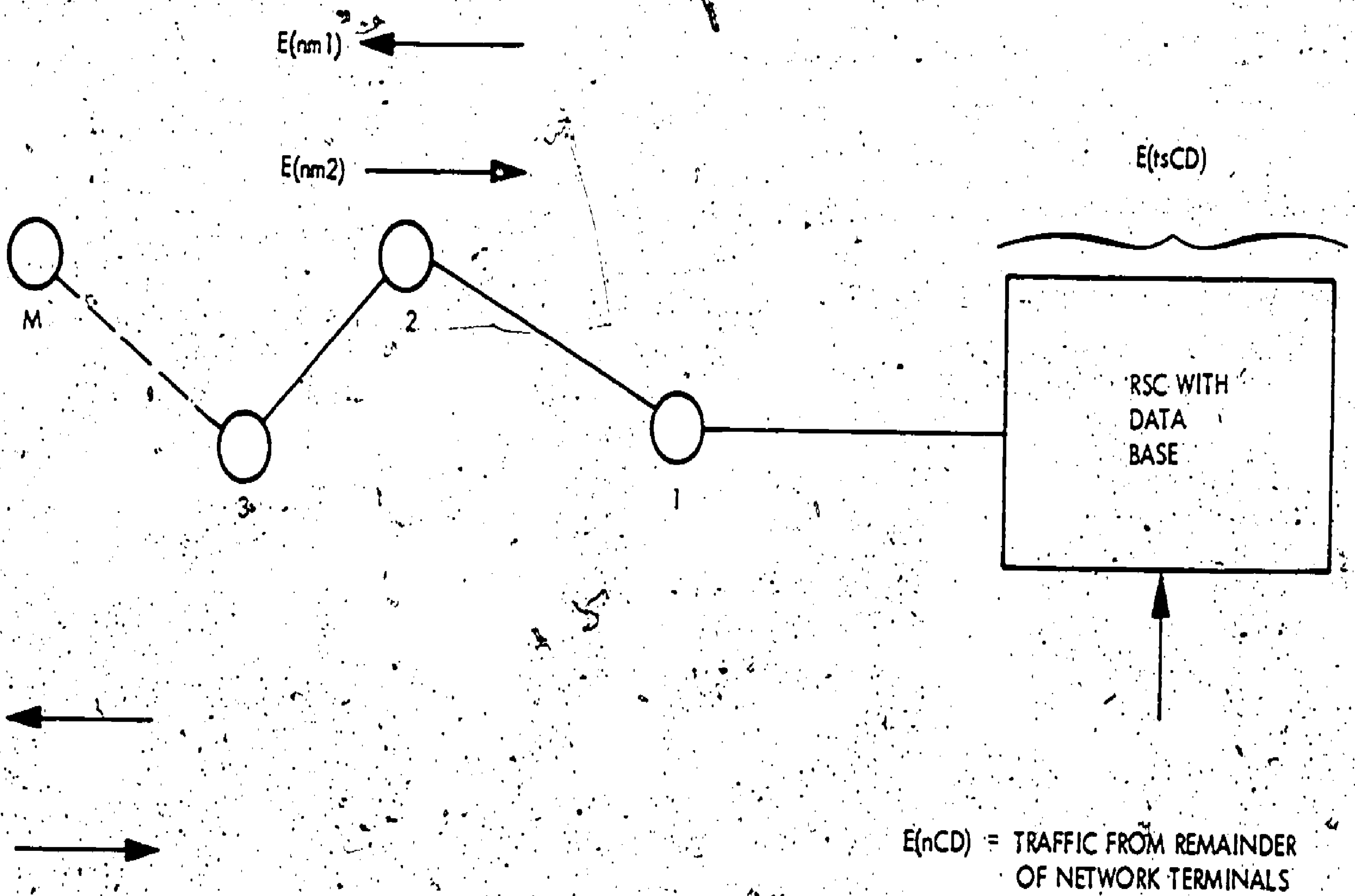


Figure 7-17. Network Inputs for Example 2

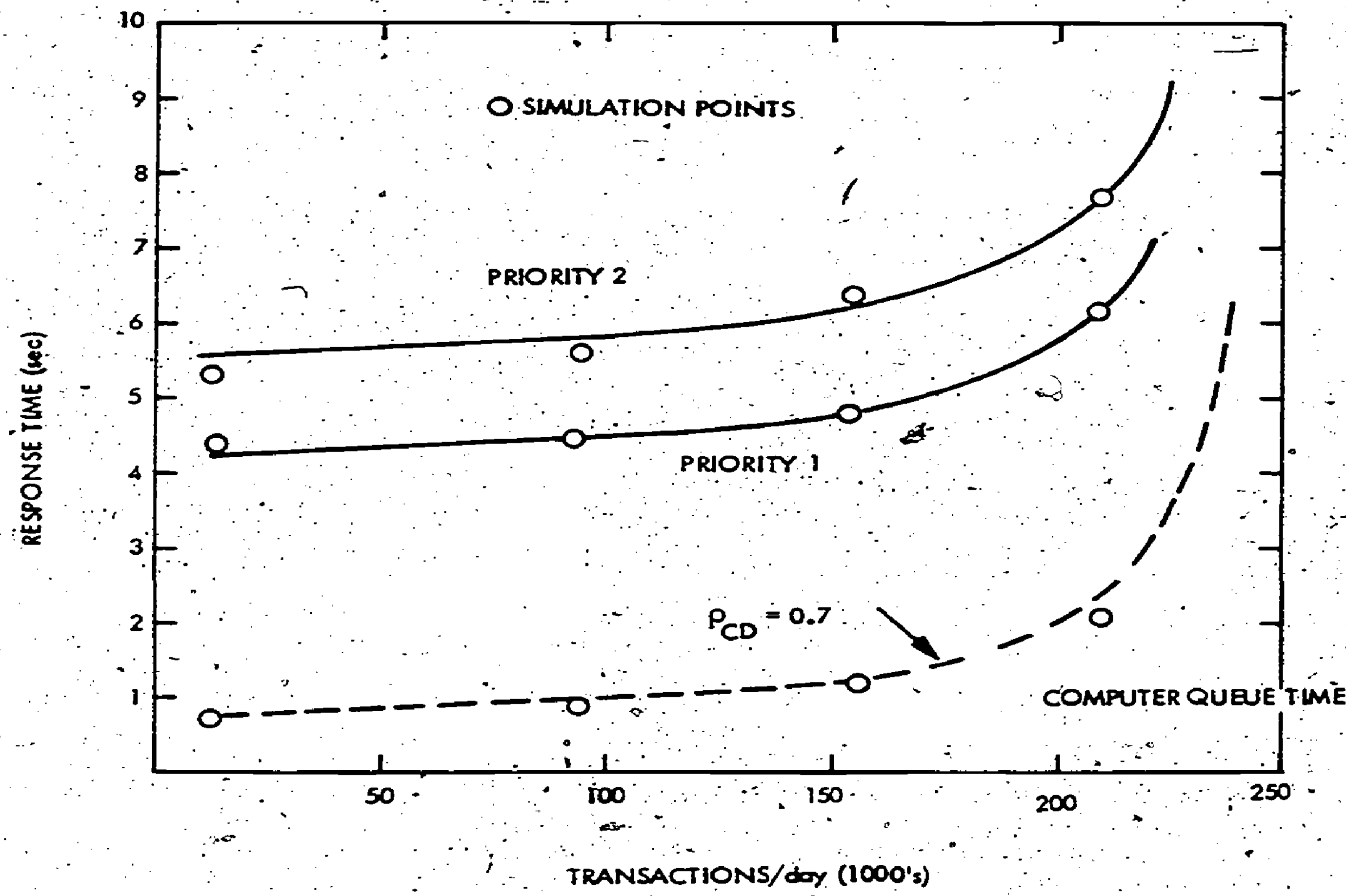


Figure 7-18. Response Time Model vs. Simulation

Table 7-5. Model Validation Input Values

Term	Value
Cm	2400 Baud
OH	13 characters
POH	10 characters
MPSEM	0.150 sec
PPSEM	0.150 sec
M	10 terminals
Uc	10 bits
L5	18 characters
L6	250 characters
L1	170 characters (output Priority 1)
L2	250 characters (output Priority 2)
L3	39 characters (input)
LM	108 characters
E(tsCD)	0.700 seconds
E(nm1)*	0.046
E(nm2)*	0.0042
E(nm3)*	0.0502
E(nCD)**	0.525

*Values for multidrop traffic used at E(nCD) = .525 (see text)

**E(nCD) = .525 for evenly loaded dual processors total computer transaction load = 2 x .525 = 1.05 transactions/sec or 90,720 transactions/day

The equations for response times in this model were

$$E(trA) = \left[\frac{M - 1}{2}\right] E(tpoll) + E(twm3) + E(tsm5) + E(tqCD) + E(twm1) + E(tsm1)$$

and

$$E(trB) = \left[\frac{M - 1}{2}\right] E(tpoll) + E(twm3) + E(tsm6) + E(tqCD) + E(twm2) + E(tsm2)$$

The dotted line in Figure 7-18 represents the time spent in queue in the computer (see Equation 11). Note that the overall life of the system in terms of ability to handle throughput is limited by the computer performance. In the system shown, the computer utilization, ρ_{CD}, reaches 0.700 at approximately 173,000 transactions per day. At this point, excessive queues can develop in the computer with small variations in throughput demand. Consequently, designers should be well into planning an upgrade when mean computer utilization hovers near 0.700. The model can be used to find the new required computer mean service time to handle throughput demand for any number of years in the future. Mean service times may be reduced in any number of ways, the most typical being use of fixed head discs, improving communications software, obtaining faster core, and implementing multiple processing units.

7.3.2 The Texas Response Time Model

The response time model for the State of Texas requires the development of further terms to handle the queueing analysis of data base terms.

The present system in Texas employs three regional switchers - one in Garland, one in Austin and one in San Antonio. Each switcher serves terminals in its general region. The Garland and San Antonio switchers are connected through communication lines to the Austin switcher. The Austin switcher, in turn, is connected to state data bases. Response time models developed in Section 7.3.1 are useful in treating response times from terminals into the Austin switch. The nature of communications between the Austin switch and the Texas data bases in Austin, however, require the development of additional queueing equations.

Figure 7-19 presents a simplified block diagram of the TLETS System and shows specific connections between the Austin switch and the three data bases providing service to the TLETS Network - the Texas Crime Information Center, (TCIC), the Drivers License Records, (LIDR), and the Motor Vehicle Department (MVD).

When the Austin switch accesses these data bases, the line over which the inquiry passes to the data base is held in reserve until the response is constructed, and then used to return the response from the data base back to the Austin switch.

In analyzing this type of "Holding" operation, it is useful to treat the data base line facilities together with the data base facility as a single system. For example, Figure 7-20 shows the TCIC system as it appears to the Austin Switch. The system has a characteristic mean waiting time, $E(tW)_s$, a mean service time, $E(tS)_s$ and a utilization, ρ_s, where

$$\rho_s = \frac{E(n)_{TCIC}}{2} E(ts)_s$$

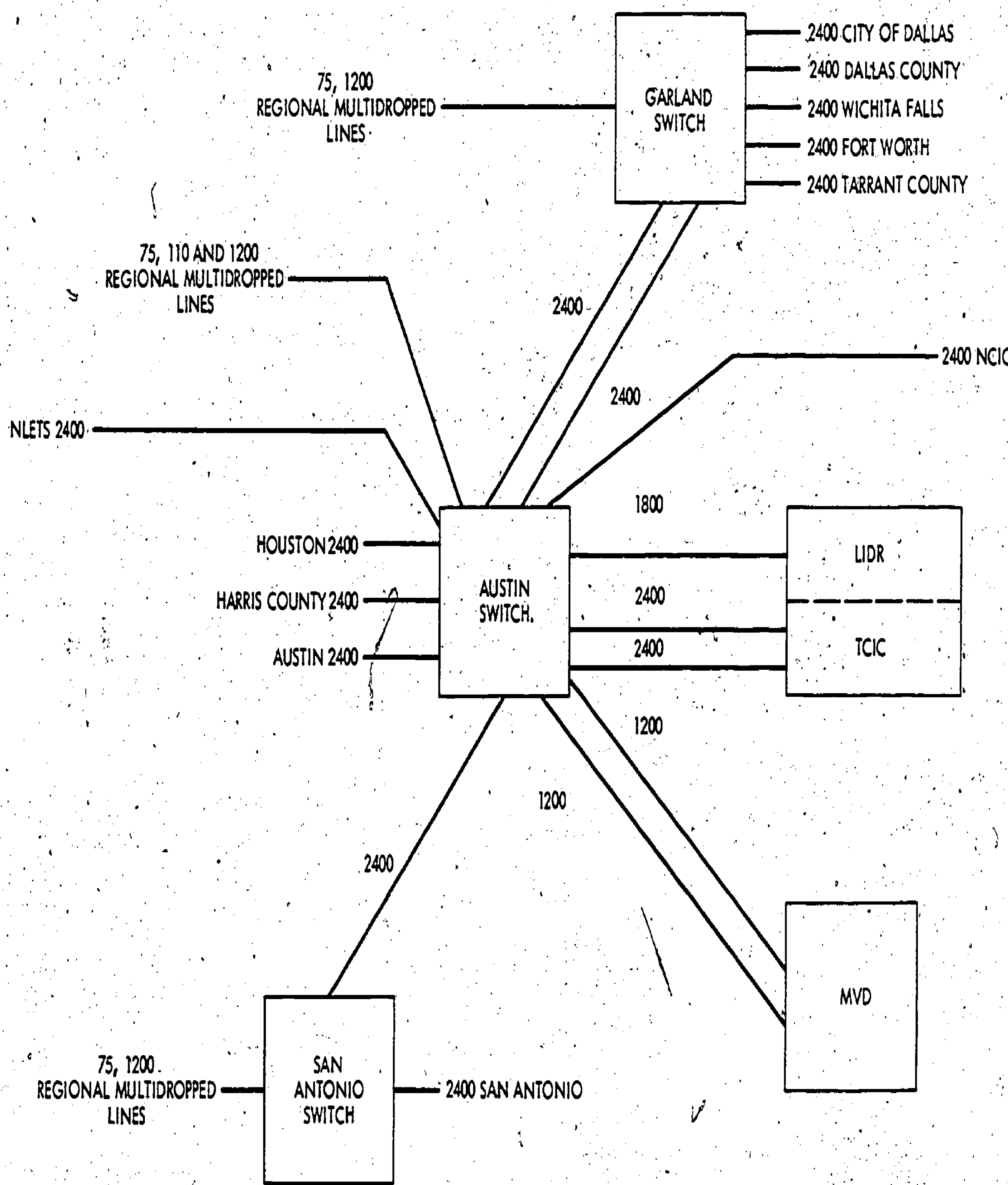


Figure 7-19. Simplified TLETS Diagram

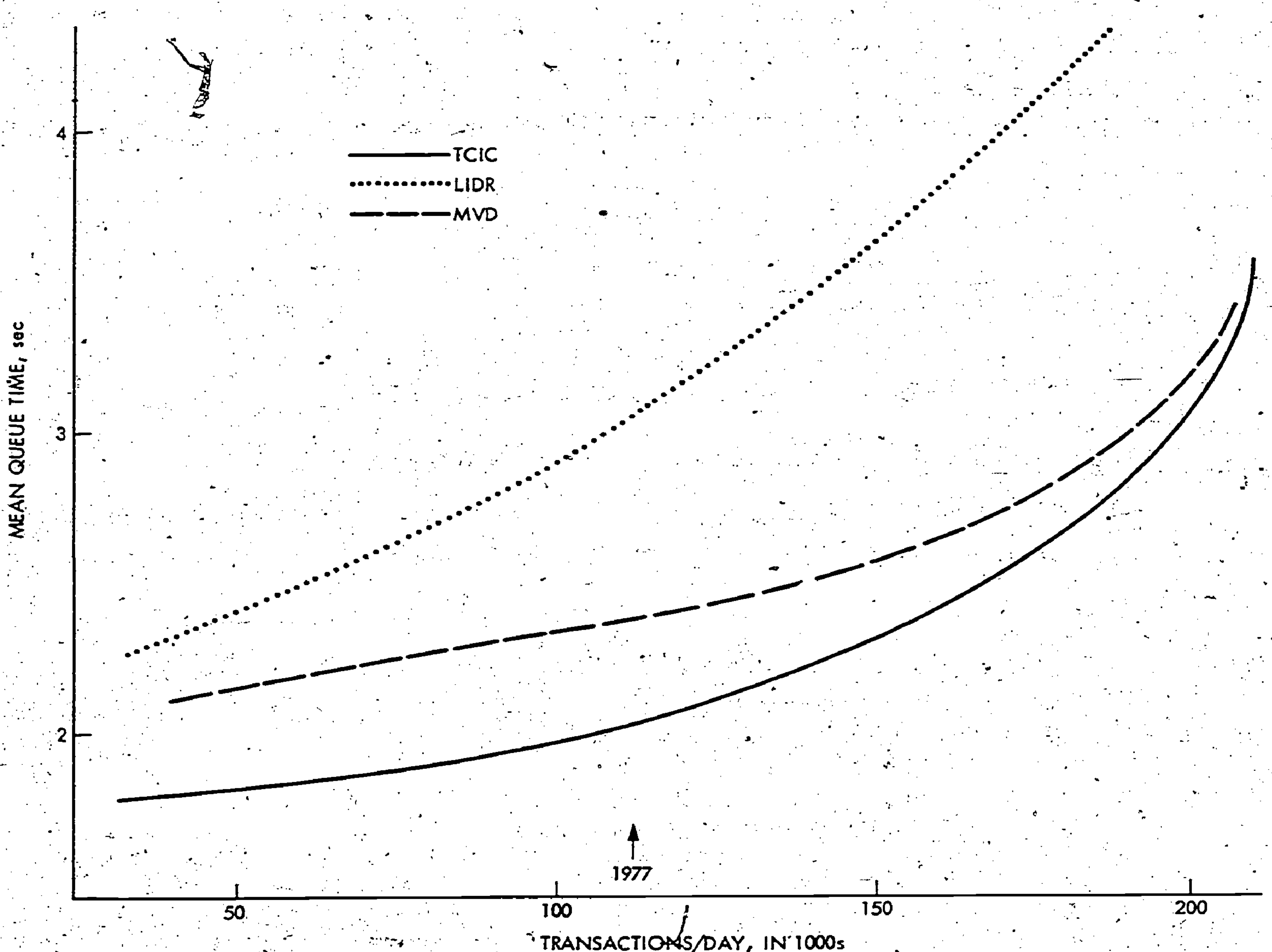


Figure 7-20. Data Base Mean Response Time as it Appears to Austin Switch

and

$E(n)_{TCIC}$ = mean arrivals per second of TCIC inquiries

Since there are two lines available to the Austin switch for service to the TCIC, the system appears to the Austin switch as a dual server queue. Thus, the value for system utilization, ρ_S, is halved by dividing the mean transaction arrival rate by 2, (see equation 3).

The TCIC computer is also loaded by LIDR traffic and traffic from in-house DPS terminals used for file update purposes. Thus, the total number of telecommunication transactions per second at the data base computer, $E(n)_{CD}$, is

$$E(nCD) = E(n)_{LIDR} + E(n)_{TCIC} + E(n)_{DPS}$$

And the computer utilization, from the telecommunications standpoint, ρ_{CD}, is

$$\rho_{CD} = E(nCD)\ E(tSCD)$$

where E(tSCD) is the mean service time per transaction of the IBM 370/155 single server data base computer.

The total mean queueing time for the TCIC system, $E(tQ)_{TCIC}$, is equal to the mean system waiting time plus the mean system service time,

$$E(tQ)_{TCIC} = E(tW)_S + E(tS)_S \tag{12}$$

From a system standpoint, the Austin switcher sees two 2400 Baud lines available for service to the TCIC system. Thus, from equation 3, the mean system waiting time for this dual server queue is given by,

$$E(tW)_S = \frac{\rho_S{}^2 E(tS)_S}{1 - \rho_S{}^2} \tag{13}$$

The mean service time in this equation, $E(tS)_S$, consists of the following components:

$E(tS)_S$ = line transmission time to TCIC from the Austin switch

+ wait time at the TCIC computer for data base service

+ mean service time per transaction at the TCIC computer

+ line transmission time back to the Austin switch from the TCIC

Note that there is no waiting time for the line when a response message is to be returned to the Austin switch from the TCIC since the line is "held" for return service once an input inquiry message begins transmission.

The components of the above equation are listed in the following paragraphs.

Let the line transmission time, (service time), from the Austin switch to the TCIC computer for input inquiries be $E(tS)_{ATI}$. Then,

$$E(tS)_{ATI} = \frac{(L(m)\ TCIC\ IN + OH)\ Bc}{C} + PAUSE \qquad (14)$$

where

L(m) TCIC IN = average message length of a TCIC input message, (inquiry).

OH = message overhead characters

U_c = bits per character

C = line capacity in Bauds

PAUSE = total pause time per message due to modem turn around time, etc.

The waiting time at the TCIC computer for a TCIC transaction is calculated by considering the probabilities that either another TCIC transaction is in front of it, an LIDR transaction is in front of it or a DPS in-house terminal transaction is in front of it, and/or all combinations of these possibilities exist. This analysis indicates that in the worst case, the wait time, $E(tW)_{TCIC}$, for a TCIC transaction in the TCIC computer can be approximated by,

$$E(tW)_{TCIC} = E(tSCD) \times \rho_{CD} \times 1.1 \qquad (15)$$

where ρ_{CD} = TCIC computer utilization

$E(tS)_{CD}$ = Mean transaction service time of the TCIC computer.

Since the value for ρ_{CD} cannot exceed 1, the multiplicative factor of 1.1 suggests that the waiting time for TCIC service for a TCIC transaction after it has arrived at the TCIC computer will never exceed one TCIC computer mean service time plus 10% of one mean service time on the average.

This finding is not unreasonable considering that the single LIDR and the two individual TCIC lines from the Austin switch are "held", as described above, so that queuing is limited at the TCIC computer. Further, LIDR and TCIC inquiries enjoy a non-preemptive priority interrupt over DPS in-house terminal messages.

The mean service time per transaction at the TCIC computer was arrived at by analyzing software statistics which provided means of determining total computer and disc time devoted to telecommunications and a measure of total transactions over a given period. The mean service time per transaction for the TCIC computer has been determined to be 394 milliseconds.

Line transmission time, $E(tS)_{ATO}$, for an output from the TCIC to the Austin Switch is given by:

$$E(tS)_{ATO} = \frac{(L(m)\ \text{TCIC out} + OH)\ B_c}{C} + \text{PAUSE} \tag{16}$$

The terms in this equation are identical to those in equation 16 with the exception of the average message length, L(m) TCIC out, which is the average message length of a TCIC response moving from the TCIC computer to the Austin switch.

We can now construct an equation for the mean service time for a transaction to the TCIC from the Austin switch as the system appears to the Austin switch. Using equations 14, 15 and 16 and a knowledge of the computer mean service time, E(tSCD), the equation for system mean service time, $E(tS)_S$, is

$$E(tS)_S = E(tS)_{ATI} + E(tSCD) \times \rho_{CD} \times 1.1 + E(tSCD) + E(tS)_{ATO} \tag{17}$$

Now, substituting equation 13 into equation 12, the desired expression for total queue time, or response time, $E(tQ)_{TCIC}$, for the TCIC system as it appears to the Austin switch becomes,

$$E(tQ)_{TCIC} = \frac{\rho_S^2\ E(tS)_S}{1 - \rho_S 2} + E(tS)_S \tag{18}$$

$$\text{where } \rho_S = \frac{E(n)_{TCIC} \times E(tS)_S}{2}$$

and $E(n)_{TCIC}$ = the mean arrivals per second of TCIC inquiries.

Equation 18 is used to analyze TCIC turn-around time from the Austin switch in the analyses carried out in Section 11 of this report. For the remainder of the network, that is, from multidrops to the Austin switch and back, the following equation is applicable.

The total response time equation for a terminal whose multidrop is connected to the Austin switch is:

$$E(tr) = \frac{M-1}{2} E(tpoll) + E(tWM2) + E(tSM2) \tag{19}$$

$$+ E(tQAS) + \frac{\rho_S^2 E(tS)_S}{1 - \rho_S^2} + E(tS)_S$$

$$+ E(tQAS) + E(tWM1) + E(tSM1)$$

where E(tQAS) = mean queue time for the Austin switch and other terms are as they are presented in equation 18.

The response time for terminals multidropped from the Garland or San Antonio switches would include additional terms accounting for remote switcher queues and interregion line queues i.e., E(tWRI1), E(tsRI1), E(twRO1), and E(tSRO1).

Thus far, we have developed an equation for the treatment of TCIC data base inquiries and responses. A similar set of equations must be developed to treat LIDR and MVD traffic.

In the case of the LIDR data base, a single line provides service for message flow between the Austin switch and the data base. For this system, as for the MVD system, a slightly different set of equations will apply. For each of these systems, as for the TCIC system, there will be a system queue time, that is, a system wait time plus a system service time. In the discussion of the TCIC system, we simply used the subscript, S, to denote the system. Let us now expand our terminology for clarity by using the following terms:

$E(tQ)_{ST}$ = system queue time for the TCIC system

$E(tQ)_{SI}$ = system queue time for the LIDR system

$E(tQ)_{SM}$ = system queue time for the MVD system

Each of these systems has a wait time and a service time as viewed from the standpoint of the Austin switch, so that, we may write

$$E(tQ)_{ST} = E(tW)_{ST} + E(tS)_{ST} \quad (20)$$

$$E(tQ)_{SI} = E(tW)_{ST} + E(tS)_{ST} \quad (21)$$

$$E(tQ)_{SM} = E(tW)_{SM} + E(tS)_{SM} \quad (22)$$

For the LIDR system, we have a single line which competes for data base service with the TCIC lines and the in-house DPS terminals. The LIDR system appears as a single server queue to the Austin switch with a mean service time $E(tS)_{SI}$ and a system utilization of ρ_{SI}. Therefore, the mean wait time for this system, $E(tW)_{SI}$, is

$$E(tW)_{SI} = \frac{\rho_{SI} E(tS)_{SI}}{1 - \rho_{SI}} \quad (23)$$

where $\rho_{SI} = E(n)_{LIDR} \times E(tS)_{SI}$.

The value for $E(tS)_{SI}$ is the sum of the following components:

$E(tS)_{SI}$ = line transmission time to LIDR data base

+ wait time at the data base computer for service

+ mean service time for the transaction at the data base computer

+ line transmission time back to the Austin Switch from the data base computer

Let the line transmission time, (service time), from the Austin switch to the LIDR data base computer for input inquiries be $E(tS)_{AII}$. Then

$$E(tS)_{AII} = \frac{(L(m)\ \text{LIDR IN} + OH)B_c}{C} + \text{PAUSE} \tag{24}$$

Where all terms are as they appear in equation 16 and L(m) LIDR IN is the average message length for a LIDR inquiry.

The waiting time of the data base computer is calculated by considering delay times for each possible combination of TCIC, LIDR, and DPS in-house terminal messages, weighting these by their probability of occurrence, and summing these weighted probabilities. The procedure follows that carried out for the TCIC system earlier. For the LIDR, this analysis indicates that the wait time, E(tW) LIDR, for service for an LIDR inquiry in the data base computer is a function of ρ_{CD} and can simply be written as:

$$E(tW)_{LIDR} = E(tS)_{CD} \times \rho_{CD} \tag{25}$$

The mean service time for the data base computer $E(tQ)_{CD}$ of 394 milliseconds is, of course, also employed here.

Line transmission time, $E(tS)_{AIO}$, for an output from the data base to the Austin switch is:

$$E(tS)_{AIO} = \frac{(L(m)\ \text{LIDR OUT} + OH)B_c}{C} + \text{PAUSE} \tag{26}$$

where terms are as they appear in equation 16 and L(m)(LIDR)OUT is the average message length for an LIDR output response message.

Equations 24, 25 and 26 are combined to give an expression for LIDR mean service time as it appears to the Austin switch:

$$E(tS)_{SI} = E(tS)_{AII} + E(tSCD) \times \rho_{CD} + E(TSCD) + E(tS)_{AIO} \tag{27}$$

Now, substituting equation 23 into equation 21, the desired expression for total queue time, or response time, $E(tQ)_{LIDR}$, for the LIDR data base system as it appears to the Austin switch becomes;

$$E(tQ)_{LIDR} = \frac{\rho_{SI}\, E(tW)_{SI}}{1 - \rho_{SI}} + E(tS)_{SI} \qquad (28)$$

Equation 28 is used to carry out the LIDR analyses presented in Section 11.

For the MVD, we have two lines providing service to the MVD data base, which is separate from the TCIC/LIDR data base, (see Figure 7-19).

This system is analyzed in a similar way as the TCIC and LIDR systems above. For the dual server MVD system queue as it appears to the Austin switch, the mean waiting time, $E(tW)_{SM}$, is,

$$E(tW)_{SM} = \frac{\rho^2{}_{SM}\, E(tS)_{SM}}{1 - \rho^2{}_{SM}} \qquad (29)$$

where $\rho_{SM} = \dfrac{E(n)_{MVD}}{2} \times \dfrac{E(tS)_{SM}}{1}$

and $E(n)_{MVD}$ = Arrival rate of TLETS traffic

The equation for $E(tS)_{SM}$ follows the rationale developed for the TCIC and LIDR systems above. Thus

$$E(tS)_{SM} = E(tS)_{AMI} + E(tW)_{MVD} + E(tS)_{CM} + E(tS)_{AMO} \qquad (30)$$

where

$E(tS)_{AMI}$ = line transmission time to the MVD data base

$E(tW)_{MVD}$ = wait time at the MVD data base computer for service

$E(tS)_{CM}$ = mean service time per transaction at the MVD computer

$E(tS)_{AMO}$ = line transmission time from the MVD data base to the Austin switch.

For the MVD system, the wait time for service for a transaction at the MVD computer, $E(tW)_{MVD}$, must consider the fact that agencies other than those associated with the TLETS network also use the MVD data base. TLETS, however, has non-preemptive interrupt priority over other users. To treat this case, we consider the total arrival rate of telecommunications messages at the MVD data base to be comprised of TLETS MVD inquiries, $E(n)_{MVD}$, and "other" arrivals at a rate of $E(n)_{MO}$. Thus, the total arrival rate of messages, $E(n)_{MT}$, is given by

$$E(n)_{MT} = E(n)_{MVD} + E(n)_{MO}$$

Therefore, utilization of the MVD data base due to TLETS traffic, ρ_{ML}, is

$$\rho_{ML} = E(n)_{MVD} \times E(tS)_{CM}$$

and the utilization due to "other" traffic, $_{MO}$, is

$$\rho_{MO} = E(n)_{MO} \times E(tS)_{CM}$$

So that the total utilization of the MVD data base computer due to telecommunications traffic, ρ_{CM}, is

$$\rho_{CM} = \rho_{ML} + \rho_{MO}$$

Under these conditions, the mean waiting time for a TLETS MVD inquiry at the MVD data base computer is,

$$E(tW)_{MVD} = \frac{\rho_{CM}\, E(tS)_{CM}}{1 - \rho_{ML}} \tag{31}$$

The mean service time for the MVD 370/155 computer per transaction is similar to the TCIC/LIDR data base computer, i.e., 394 milliseconds.

Thus, the total system mean queueing time, $E(tQ)_{MVD}$, for MVD data base system as it appears to the Austin switch is

$$E(tQ)_{MVD} = \frac{\rho^2{}_{SM}\, E(tS)_{SM}}{1 - \rho^2_{SM}} + E(tS)_{SM} \tag{32}$$

Equation 32 is used in the analyses of the MVD system carried out in Section 11.

Sample Calculation

By way of example, let us consider the total mean response time for a terminal connected to the Garland switcher into the TCIC system and back to the terminal. In this sample calculation we shall use TLETS circuit 4 out of Garland - a 75 Baud multidropped line with 10 terminals. The communication path is over the multidropped line, through the Garland switch, over a dual server set of interregion lines, through the Austin switch, through the TCIC system as it appears to the Austin switch and back through each component to the inquiring terminal.

The equation components are shown in Table 7-6.

Table 7-6. Equation Components

Equation Component	Meaning
$E(tr) = \left[\frac{M-1}{2}\right] E(tpoll) + E(tWM2) + E(tSM2)$	Wait on multidrop for service (priority 2, input) plus service time on multidrop to Garland switch
$+ E(tQ)_{CR}$	Wait plus service time at Garland switch for TCIC input message
$+ E(tQ)_{RI}$	Wait plus service time for dual server inter-region lines - input message - one priority
$+ E(tQ)_{CA}$	Wait plus service time at Austin switch for input message
$+ E(tQ)_{TCIC}$	Wait plus service time for TCIC system as it appears to Austin switch
$+ E(tQ)_{CA}$	Wait plus service time through Austin switch for output message
$+ E(tQ)_{RO}$	Wait plus service time for dual server inter-region lines - output message - one priority
$+ E(tQ)_{CR}$	Wait plus service time at Garland switch for TCIC output message
$+ E(tSM1)$	Wait plus service time for output message onto multidrop line - (priority 1, i.e., output over input)

The sample calculation presented here makes use of numerical values listed in Table 7-7.

The equation components of Table 7-6 then become;

$$\left[\frac{M-1}{2}\right] E(tpoll) = \left[\frac{M-1}{2}\right]\left[\frac{POH \cdot U_c}{C_m} + PPSEM\right] = \quad 3.15 \text{ sec}$$

$$E(tWM2) = \frac{em\ E(tSM2)}{(1-em1)\ (1-em1-em2)} = \quad 5.9 \text{ sec}$$

$$E(tSM2) = \frac{(Lm2 + OH)\ Uc}{Cm} + MPSEM = \quad 15 \text{ sec}$$

$$E(tQ)CR = \frac{E(tS)CR}{1-\rho_{CR}} = \quad 0.35 \text{ sec}$$

$$E(tQ)RI = \frac{E(tS)RI}{1-\rho_{RI}} = \quad 0.55 \text{ sec}$$

$$E(tQ)CA = \frac{E(tS)CA}{1-\rho_{CA}} = \quad 0.86 \text{ sec}$$

$$E(tQ)\ TCIC = \frac{\rho ST\ E(tS)ST}{1-\rho ST} + E(tS)ST = \quad 2.1 \text{ sec}$$

$$E(tQ)CA = \text{See Above} = \quad 0.86 \text{ sec}$$

$$E(tQ)RO = \frac{E(tS)RO}{1-\rho RO^2} = \quad 0.9 \text{ sec}$$

$$E(tQ)CR = \text{See Above} = \quad 0.35 \text{ sec}$$

$$E(tWM1) = \frac{\rho m\ E(tS)M1}{(1-m1)} = \quad 4.7 \text{ sec}$$

$$E(tSM1) = \frac{(Lm1 + OH)\ Uc}{Cm} + MPSEM = \quad 22.4 \text{ sec}$$

Thus the total response time, E(tR), in this sample calculation is the sum of the above terms:

$$E(tR) = 57.1 \text{ sec}$$

Table 7-7. Sample Calculation Input Values

Term	Meaning	Value
M	Number of terminals on multidrop	10
Cm	Line capacity of multidrop	75 Baud
POH	Polling overhead	3 char
PPSEM	Total line turn around time for a poll	0.4 sec
MPSEM	Total line turn around time for a message	0.4 sec
OH	Message overhead on multidrop	12 char
Uc	Units per character on multidrop	7.5 bit/char
Lm2	Input average message length from multidrop - priority 2	134 char
Lm1	Output average message length to multidrop - priority 1	208 char
Lm	Overall average message length on multidrop	177 char
E(nM1)	Arrival rate of output messages to multidrop	0.006/sec
E(nM2)	Arrival rate of input messages from multidrop	0.005/sec
E(tS)CR	Mean service time of Garland Switcher	0.300 sec
E(n)CR	Total arrival rate of messages at Garland Switcher	0.5 sec
Cr	Line capacity of interregion lines	2400 Baud
MPSER	Total line turn around time per message on interregion lines	0.056 sec
LmRI	Average message length of messages from Garland Switcher to Austin Switcher	134 char

Table 7-7. Sample Calculation Input Values (Continuation 1)

Term	Meaning	Value
LmRO	Average message length of messages from Austin Switcher to Garland Switcher	208 char
E(n)RI	Rate of message flow from Garland to Austin	0.2/sec
E(n)RO	Rate of message flow from Austin to Garland	0.22/sec
UcR	Units per character on high speed lines	8 bits/char
E(tS)CA	Mean service time of Austin Switcher	0.400 sec
E(n)CA	Total arrival rate of messages at Austin Switcher	1.34/sec
CAT	Line capacity for lines between Austin Switcher and TCIC	2400 Baud
OHH	Overhead characters on high speed lines	13 char
PSAT	Total line turn around time per message on TCIC lines	0.032 sec
LmATI	Average message length of messages from Austin Switcher to TCIC	183 char
LmATO	Average message length of messages from TCIC to Austin Switcher	168 char
E(tS)CD	Mean service time of TCIC computer (data base computer)	0.400 sec
E(nT)	Arrival rate of messages to TCIC data base	0.23/sec
E(nI)	Arrival rate of messages to LDIR data base	0.12/sec
E(nT)	Arrival rate of transactions from DPS in-house terminals	1.27/sec

SECTION 8

STACOM/TEXAS NETWORK STUDIES

STACOM/TEXAS Network Studies consist of examining five optional network configurations, and the execution of three additional network studies.

Options 1, 2 and 3 investigate potential cost savings in trading off network line costs with regional switcher costs. Options 4 and 5 examine cost tradeoffs between construction of a separate network to accommodate predicted growth in New Data Type traffic, and the integration of New Data Type criminal justice traffic with TLETS traffic into a single network.

Three additional network studies consider: (1) network cost increases as terminal mean response times are decreased, (2) the impact on network cost and performance due to adding digitized classified fingerprints as a data type, and (3) the relative difference in network costs between maintaining and abandoning network line service oriented toward the existing regional Councils of Government.

The following paragraph discuss these studies in more detail.

8.1 OPTIONS 1 THROUGH 3

As the number of regional switchers serving terminals within their regions is increased, total network line costs may be expected to decrease due to the fact that total network line length has decreased. The placement of additional regional switchers, however, imposes an additional network cost which may or may not offset cost savings due to decreased line lengths.

Options 1 through 3 seek to understand the effects of the placement of regional switchers throughout the State of Texas on costs.

Option 1 considers the use of a single regional switcher located in Austin.

Option 2 analyzes the use of two regional switchers. One switcher is located in Austin and the second switcher is located in one of four different cities in an attempt to search for a minimum cost two region configuration. The four locations considered were restricted to the major candidate cities of Dallas, Midland, Lubbock and Amarillo.

Option 3 considers costing effects of the use of three regional switchers. Two of the switchers are located in Austin and Dallas respectively and the location of the third is varied from Houston, Midland, Lubbock, Amarillo and San Antonio. The San Antonic location is included to provide a comparison of optimized networks with an optimized network with switchers located as they are in the present TLETS system.

8.2 OPTIONS 4 AND 5

The New Data Type traffic communication requirements can either be met by constructing a separate network dedicated to these needs or by integrating this traffic flow with the TLETS Network.

Option 4 considers cost totals for operating separate networks for the TLETS System and the New Data Types.

Option 5 considers total costs for meeting traffic requirements of both TLETS and New Data Types in a single integrated network.

In both cases, the TLETS network considered will be the least cost network identified from the studies of Options 1 through 3.

8.3 COST SENSITIVITY TO RESPONSE TIME

A study designed to clarify the extent to which total network costs increase as terminal response times are reduced is to be carried out. As response times are reduced from the 9 second goal specified in the STACOM/TEXAS Functional Requirement, networks will be called for that drop fewer terminals on given multidrops hence, require more lines. Higher speed lines may also be required as response time requirements are made more stringent. These factors will tend to increase overall network costs.

This study will determine the extent of cost increases as a function of decreasing network response times for the least cost TLETS network that results from studies of Options 1 through 3.

8.4 IMPACT OF ADDING FINGERPRINTS AS A DATA TYPE

Estimates of fingerprint traffic in Texas assume the use of automated digital classifying equipment at strategic locations throughout the state. The potential impacts of the addition of such data types to the TLETS Network in terms of cost and performance are a matter of interest. From the performance standpoint the principal consideration is the extent to which the addition of fingerprint data may affect response time characteristics of higher priority officer safety type messages.

This study determines the extent of such impacts on the least cost TLETS Network which develops from Options 1 through 3.

8.5 COG SERVICE STUDY

In the present TLETS system, multidropped lines providing service to agencies throughout the state are generally organized such that single multidrop lines service agencies in jurisdictions of a single Council of Government, (COG).

This study investigates the potential for line savings if network multidropping is carried out without the restriction of serving COG agencies on separate lines.

The specific COGs considered in this study are shown in Section 11 of this report, Figure 11-4.

SECTION 9

TEXAS NETWORK COST ANALYSIS

This section presents assumptions and bases for costing STACOM/TEXAS Network Options. Total network costs are comprised of recurring costs and one-time installation costs. Table 9-1 shows the basic cost items considered and describes the meaning of each item.

The costs considered here include the primary items that affect relative costs between network configurations involving different numbers of switchers and different traffic types. Costs for required upgrades of the central data bases in Austin and in the Austin Switcher are not included, since these costs are present to the same degree in all of the alternative network configurations studied. Detailed costing of data base computer upgrades is not within the scope of the STACOM Study which is primarily oriented toward network alternatives. Basic data base computer performance requirements, however, are treated in Section 12 of this report.

The following paragraphs develop costing values for each item listed in Table 9-1.

9.1 LINE, MODEM, AND SERVICE TERMINAL COSTS

The line tariff structure used for costing of lines, modems and service terminals for the Texas computer network topology runs was supplied by Southwestern Bell Telephone Company. Table 9-2 displays

Table 9-1. Cost Items and Descriptions

Item	Recurring Costs	On-Time Installation Costs
Lines, Modems, Service Terminals	Annual Tariff Costs	Modem and Service Terminal Installation
Terminals	Maintenance Costs	Purchase Costs
Regional Switchers	Maintenance Costs	Purchase Costs
Switcher Floor Space	Regional Switcher Site Rental Costs	Regional Switcher Site Preparation Costs
Switcher Backup Power	Maintenance Costs	Purchase Costs
Switcher Personnel	Regional Switcher Personnel Salaries	Not Applicable
Engineering	Not Applicable	Network Procurement Costs

Table 9-2. STACOM/Texas Line Tariff

Line Speed (Baud)	Cost/mi/mo		Modem		Service* Terminals		Drop Charge
	IXC $	Telpak $	Inst $	Month $	Inst $	Month $	Month $
1200	3.00	0.60	50.00	22.00	10.00	15.00	10.00
2400	3.00	0.60	100.00	54.00	10.00	15.00	10.00
4800	3.00	0.60	100.00	135.00	10.00	15.00	10.00

*For TELPAK the term Channel Terminal is used
For IXC the term Connection Arrangement is used

installation and monthly charges used. For 1200, 2400 and 4800 Baud lines the table shows costs per mile per month for the Inter eXchange Charges (IXC) when a non-TELPAK city is involved. The TELPAK column shows cost per mile per month for connections between any two cities in the TELPAK inventory. Cities in the TELPAK inventory do not stay constant over long periods of time, however, for the purposes of this study, the TELPAK cities listed in Table 9-3 were used.

9.2 TERMINAL COSTS

The State of Texas has recently procured replacement terminals for the TLETS system capable of operation at 1200 Baud and at higher rates. It is planned that these terminals will be placed at user agencies within the next few years. The STACOM/Texas Network study assumes that 564 terminals will be operational by 1978 and continue operation through 1985. Since the life of the system is greater than 3 years, it is assumed that the cost effective policy of purchasing the terminals and carrying a monthly maintenance charge would be carried out.

In this costing exercise, the unit cost per terminal is known to be $8,847 and the annual maintenance charge is $1,260 ($105/month).

9.3 REGIONAL SWITCHER COSTS

The purchase price for regional switchers now in use in the TLETS system in Garland and San Antonio range between $320,000 and $380,000. It is assumed that similar regional switching facilities would be incorporated in any future network making use of them. For simplicity in network topology comparisons, a purchase price of $350,000 is assumed.

The annual maintenance charge for regional switchers is estimated at $18,000 ($1,500 per month).

Table 9-3. Texas Telpak Inventory Used in STACOM/Texas Study

1. Abilene	25. Donna	49. Pharr
2. Alpine	26. Edinburg	50. Plainview
3. Amarillo	27. El Paso	51. Port Arthur
4. Angleton	28. Euless	52. Richmond
5. Arlington	29. Fort Stockton	53. Rusk
6. Atlanta	30. Fort Worth	54. San Angelo
7. Austin	31. Galveston	55. San Antonio
8. Beaumont	32. Gonzales	56. Seguin
9. Belton	33. Greensville	57. Sherman
10. Big Spring	34. Harlingen	58. Sweetwater
11. Brenham	35. Houston	59. Tahoka
12. Bridge City	36. Huntsville	60. Temple
13. Brownsville	37. Kilgore	61. Terrell
14. Brownwood	38. Killeen	62. Texarkana
15. Bryan	39. Kingsville	63. Texas City
16. Canyon	40. Laredo	64. Tyler
17. Childress	41. Longview	65. Vernon
18. Colorado	42. Lubbock	66. Victoria
19. Commerce	43. Midland	67. Waco
20. Conroe	44. Mcallen	68. Weslaco
21. Corpus Christi	45. Mt. Pleasant	69. Wharton
22. Corsicana	46. Nacogdoches	70. Wichita Falls
23. Dallas	47. Odessa	71. Yoakum
24. Denton	48. Paris	

9.4 REGIONAL SWITCHER FLOOR SPACE

It is assumed that 1000 ft^2 of floor space is sufficient for housing a regional switcher facility including personnel office space. Facility preparation costs are estimated at $30,000 per switcher facility. These preparation costs do not appear in cases where switchers are located in Dallas or San Antonio. Monthly rental is estimated at $0.40 per ft^2 so that monthly rental per switching facility is $400.

9.5 SWITCHER BACKUP POWER

Uninterruptable power supplies, (UPS), are considered necessary at each regional switching facility to ensure commercial power continuity during momentary power transients as well as over extended periods.

Solid-state static inverter type UPS including a rectifier/charger, and autobypass switch are available at approximately $13,000 per unit. Batteries for the unit are estimated to cost $2,500. A gasoline engine generator for use when lengthy outages occur include weatherproof housings and auto transfer switches that operate when commercial power fails. These units are priced at $4,500 each.

The total one-time purchase price for each installation is, therefore, $20,000. A maintenance contract for both the UPS and engine generator is estimated at $500 per month.

9.6 ENGINEERING COSTS

Engineering costs associated with network implementation were estimated for single and multiple region configurations. Table 9-4 shows manpower estimates in man-months for assumed engineering costs. The values shown for the single region separate New Data Network are reduced with respect to other single region networks since the network is considerably smaller. Cost per man-month including overhead and benefits is estimated at $4,000.

9.7 PERSONNEL COSTS

Regional switching facilities require supervisory, programming and computer operations personnel. This study assumes that each regional switcher facility requires one supervisor, two programmers and six computer operators. Two computer operators are provided per shift for safety reasons so that at no time during a 24-hour day the facility is manned by one person alone. Table 9-5 presents estimated salaries for the required personnel.

9.8 COST SUMMARY

Table 9-6 summarizes recurring and one-time installation costs developed in this section for convenient reference.

9.9 TEXAS NETWORK IMPLEMENTATION

The networks presented in this section are designed to meet TEXAS traffic requirements through the year 1985. A cost analysis on the feasibility of constructing an intermediate network to meet 1981 traffic level requirements, and then upgrading this network in 1981 to meet 1985 traffic level requirements, as opposed to building a single network to meet traffic requirements through 1985, was carried out. It was found that building a single network now to meet 1985 traffic requirements would not involve additional costs over intermediate phasing of network upgrades. A single exception to this rule occurs in the cases of networks where New Data Types are involved, (Options 4 and 5).

Growth in new data type traffic volumes from the present through 1985 is such that it is less costly to implement one network to handle traffic volumes up to 1980 and to then add to the network to meet traffic demands from 1981 through 1985.

Table 9-4. Engineering Cost Estimates (in man months)

Task	2, 3 and 4 Regions	1 Region New Data Types	1 Re[illegible] Oth[illegible]
Final Functional Requirements	2	1	
Switcher Design Spec/RFP	4	-	
Network Design Spec/RFP	4	1	
Switcher Facilities RFP	4	-	
Switcher Procurement Monitor	6	-	
Network Procurement Monitor	6	3	
Facilities Procurement Monitor	6	-	
Switcher Test Plan	2	-	
Switcher Testing	2	-	
Network Test Plan	2	1	
Network Testing	2	1	
Documentation	6	1	
Supporting Analysis	6	2	
User Operators Manual	6	2	
Totals (Man Months)	58	12	3
Approximate Cost at $4K/MM ($K)	230	50	13

Table 9-5. Personnel Costs

Personnel	No. Required	($K) Annual Salary	($K) Annual Cos[illegible]
Supervisor	1	20	20
Programmers	2	18	36
Operators	6	12	72
Total Personnel Annual Cost			$128K

Table 9-6. Cost Summary by Item

Item	Annual Recurring Cost Per Unit ($K)	One-Time Installation Per Unit ($K)
Lines, Modems, Service Terminals	See Tariffs and Costs; Tables 4-2, 4-3 and 4-4	See Tariffs Costs; Tabl 4-3, and 4-
Terminals	1.260	8.847
Regional Switchers	18.0	350.0
Switcher Floor Space	4.8	30.0
Switcher Backup Power	6.0	20.0
Switcher Personnel	128.0	None
Engineering	None	50/130/230 See paragra

For these reasons costs presented in Sections 13 and are based on the construction in 1978 of networks that will acco predicted traffic levels through 1985 with the exception of netw involving new data types that are phased as indicated.

Thus, TEXAS Networks can be regarded as involving co a period of eight years. Therefore, total eight year costs incl installation and recurring costs are used as a basis of network cost comparisons.

262

SECTION 10

STACOM/TEXAS NETWORK FUNCTIONAL REQUIREMENTS

This section presents the Functional Requirements for Texas State Criminal Justice Telecommunications (STACOM) Network a developed by the JPL/TEXAS STACOM Project Study.

The Functional Requirements document is the top level specification and serves as a base for all lower level design spec tions for the total network, including functional and design speci tions of network elements. All subsequent documentation must be c tent with this specification.

This section provides a basic description of the Texas network, definition of network elements, and defines the required of the total network as well as the network elements. The descrip intended to provide a succinct overview of network functions and r ments. Further details related to how the functional requirements shall be implemented shall be contained in later requests for prop

The use of the term STACOM Network refers to either a network or a group of networks that meet the functional requiremen outlined herein.

10.1 NETWORK PURPOSE

The purpose of the STACOM Network is to provide efficie telecommunications capable of transporting information between Texa criminal justice agencies on a statewide scale and to and from spec interstate criminal justice agencies. Criminal justice agencies ar agencies whose primary functions encompass law enforcement, prosec defense, adjudication, corrections and pardon and parole. The netw shall be designed to handle communication requirements among these agencies projected through the year 1985.

10.2 STACOM USERS

The STACOM Network shall be comprised of one or more ne serving user requirements, to be determined during detailed network analysis and design phases of the STACOM Project. Users shall cons the present and future users of the Texas Law Enforcement Telecommu nications System, (TLETS), and other authorized criminal justice ag within the Texas State Criminal Justice System.

10.3 NETWORK CONFIGURATION DEFINITIONS

The basic configuration of the STACOM Network is an arr network system terminations connected through Regional Switching Ce (RSC), facility(s) to data base facilities.

Each system termination on the STACOM Network shall be defined as one of three types:

a. individual terminals

b. groups of terminals in cities

c. interfaces to regional criminal justice systems

Any of the system terminations within a network shall be able to communicate with any other system termination. Each system termination shall not be routed through more than one RSC in gaining access to the Austin data bases, not including the Austin switching facility, during normal network operation.

10.4 MESSAGE CHARACTERISTICS

10.4.1 Digital Message Types

The STACOM Network shall handle the following six basic types of messages.

- Data File Interrogations/Updates

  These messages shall be inquiries, entries, modifiers, cancels, locates, clears and responses to and from a data file at the state or national level. The text is generally in fixed format.

- Administrative Messages

  These are messages between network users which do not involve data file access. The text is in a less restrictive format.

- Network Status

  These messages shall provide information at terminals initiating messages in the event that destination terminals or intermediate switchers or lines are unable to function or specific files or portions of files are not functional.

- Error Messages

  These messages shall contain information regarding the nature of errors detected in transmitted messages. Messages in which errors are detected are not automatically retransmitted on the network, but are resent at the users discretion.

264

- Diagnostic Messages

  Messages of a diagnostic nature shall be included with or shall accompany network status and error messages when feasible.

- Fingerprints

  Digitized representations of fingerprints shall be included on the STACOM Network.

10.4.2 Message Content

Criminal justice messages shall contain the following information in known locations:

- Internal TLETS messages shall contain
  - Message Origin
  - Message Type
- External TLETS messages shall contain
  - Message Type
  - Message Sequence Number
  - Message Origin

10.4.3 Message Lengths

Digital messages transmitted over the STACOM Network shall not exceed 500 characters in length. Actual messages exceeding 500 characters shall be blocked in message segments which shall not exceed 500 characters each. Multisegment messages shall have a single overall message number and distinct message segment numbers. Each segment shall be transmitted as a separate message. Personnel at destination terminal(s) must reassemble the overall message upon reception.

Multisegment fingerprint, multisegment file update messages, and other multisegment messages whose final destination is a computer, or data base file, shall be reassembled by software at the destination point.

10.5 NETWORK MESSAGE HANDLING

10.5.1 Message Routing

The STACOM Network shall provide communications routing for all messages between any of its system terminations.

The following specific routing capabilities shall be provided:

- Data base inquiry/update messages shall be routed from the originating terminal to the Austin data bases through no more than one intermediate Regional Switching Center, not including the Austin switcher, under normal network operation. Interface routing to NLETS and the NCIC shall be maintained as in the present Texas TLETS system.

- Administrative messages shall be routed from the originating terminal to the destination terminal through no more than two RSCs under normal network operation. Administrative messages shall also have a capability for ALL POINTS routing as currently employed by the Texas TLETS system.

- Digitized fingerprints data shall be routed from the originating terminal to the Identification and Criminal Records Division of DPS, Austin, through no more than two RSCs under normal network operation.

Message routing shall be accomplished by the regional switcher(s) utilizing the destination information in the message. Single messages destined for the same region in which they originate shall be switched to the appropriate system termination by the regional switcher servicing that region.

When more than one system termination is specified as the destination point, the message shall first be routed to appropriate STACOM Network Management who may exercise the option to grant message approval. The appropriate messages shall then be generated and transmitted.

10.5.2 Message Prioritization

Prioritization of messages shall be incorporated in the STACOM Network to the extent required to meet the message response time goals outlined in paragraph 10.5.3.

Messages shall be handled on a non-preemptive priority basis. In this scheme, messages or message segments in process of being transmitted shall not be interrupted, but allowed to complete before higher priority messages are honored.

Under the above conditions, the STACOM Network shall be capable of recognizing and handling message types in accordance with the following prioritization:

Priority 1: Items that may be directly related to officer safety, such as inquiries into TCIC, LIDR, MVD, and NCIC files and NLETS messages.

286

Priority 2: Administrative messages related to officer safety or tactical needs, and CCH Summaries.

Priority 3: Administrative messages not related to officer safety, fingerprints, SJIS, OBTS, CCH Rap Sheets, and other criminal justice data consisting of large numbers of message segments.

The assignment of message types by the STACOM Network to a given priority level shall be under computer software control so that such assignments may be altered by STACOM Network Management as needs arise.

10.5.3 Response Time Goals

Response time for the STACOM Network is defined as the time duration between the initiation of a request for service of an inquiry message by the network at a system termination and the time at which a response is completed at the inquiring system termination.

The response times shown below are maximum times for mean response times and for response times of messages 90% of the time. These response times represent maximum allowable goal values on the STACOM Network.

10.5.4 Line Protocol

The STACOM/TEXAS Network shall employ standard Bell 8A1 line protocol. All network equipment shall be capable of conversion to Bell 85A1 protocol.

- Half duplex
- The standard interface to system terminations shall be half duplex
- Full duplex

STACOM Response Time Goals Maximums

Message Priority	Mean Response Time	90% of Responses to Inquiries Received in Less Than
1	9 sec	20 sec
2	1 min	2.3 min
3	2 hrs	4.5 hrs

- Full duplex line discipline may only be used interregionally

10.5.5 Message Coding

All STACOM Network messages shall be coded using the American Standard Code for Information Interchange (ASCII), USAS X3.4-1968. Message coding for interaction with NCIC, and NLETS systems shall conform to existing practices of the Texas TLETS Network.

10.5.6 Error Detection

The STACOM Network regional switchers shall provide for bit error detection of erroneous messages. Error messages shall be transmitted to system terminations in accordance with present practices of the Texas TLETS Network. The computer shall detect format errors and transmission errors on incoming messages and notify the sending terminals appropriately. The computer shall also detect off-line or inoperative terminals.

Messages shall not be automatically retransmitted upon error detection. Messages may be retransmitted at the discretion of the user.

10.5.7 Network Status Messages

The STACOM Network shall provide for notification to system terminations of any conditions which prevent operation in the normal specified manner. System terminations shall receive such status message upon attempting to use the network when the network is in a degraded mode. Status messages shall include status on conditions of criminal justice files, portions of files, computer and line hardware difficulties and message queues, when appropriate.

10.6 SYSTEM TERMINATIONS

STACOM Network system terminations having interface capability of 1200 to 2400 BPS shall interface with the network using half duplex protocol. Terminals shall have the capability of off-line construction of input messages and for hard copy production of received messages. Terminal printers shall be capable of 1200 BPS operation.

All terminals shall be pollable, provide for parity error detection, and employ CRT display screens.

The number of system terminations per multidropped line shall not exceed 20.

10.7 REGIONAL SWITCHING CENTERS

The STACOM/TEXAS Network shall be comprised of one Regional Switching Center (RSC) with redundant data bases located in Austin and up to four additional RSCs without data bases. Regional Switching Centers shall determine for each message the:

- Message type
- Message destination
- Message number
- NCIC Identifiers of sending department
- Sending authority

The following further describes the capabilities of each type of RSC.

10.7.1 Switchers Without Data Bases

10.7.1.1 Communication Line Interfaces. An input communication line interface shall convert incoming serial bit streams into assembled characters and furnish electrical interface for the modem and logic required for conditioning.

An output communication line interface shall convert characters into a bit stream. It shall also provide logic necessary to condition the modem for transmission and furnish the necessary electrical interface.

RSCs shall be designed to handle either full or half duplex line protocols on any line interface.

10.7.1.2 Message Assembly/Disassembly. A message assembly unit shall assemble messages by deblocking the character stream.

A message disassembly unit shall segregate messages into logical blocks for output. It shall also disassemble the blocks into a character stream for presentation to the communication line interface.

10.7.1.3 Error Control. The error control function shall provide error detection capability and initiate error messages in accordance with requirements outlined in Section 10.5.6. The error detection function is highly dispersed. Character parity is most efficiently checked during assembly of characters in the interface. Block parities are checked upon assembly of blocks. Additionally, all internal data transfers shall require a parity check.

10.7.1.4 Message Control and Routing. The message control and routing function shall provide logic which examines the assembled messages, determines its priority, destination, and forms the appropriate pointers and places them in the proper queue, (the pointers are queued, not the messages).

Message routing shall be performed by RSCs in accordance with procedures outlined in Section 10.2.2.1.

In addition, this function shall maintain network status information for the purposes of determining availability of alternate communication paths in degraded modes of operation.

10.7.1.5 Queue Control. This function shall provide buffer and queue storage used to assemble input messages, buffer them for output and to form space to queue the message pointers.

Regional switchers shall maintain necessary queues for each system termination they service and for interregional traffic. These queues shall hold messages that cannot be sent immediately due to line usage conflicts. However, the regional switchers shall not maintain a long term store and forward capability. In the event that queue space is full, the regional switcher shall not accept any more messages and shall notify the other switcher not to accept messages destined for the switcher in question.

This capability shall be provided through use of upper and lower queue thresholds specifiable by the regional switcher operator. All system terminations sending messages to the regional switcher which would demand queue space in excess of the upper threshold shall be sent negative acknowledgement responses. Once the upper threshold has been exceeded, the regional switcher shall enter the input control mode (i.e., the regional switcher shall output only). Any request for regional switcher service while it is in the input control mode shall result in a wait acknowledgement being sent to that system termination. The regional switcher shall stay in the input control mode until the lower threshold is attained.

Queue control procedures at the regional switchers shall be comprised of the following basic functions:

- Provide three independent queues for each system termination by priority as required.
- Dynamic queue management where a common core pool is made available for queueing on an as-needed basis.
- Queue overflow management as discussed above.
- Provide queue statistics for input to statistics gathering function, as discussed in Section 11.7.1.7.

270

10.7.1.6 Line Control. The line control function shall provide the capability of controlling and ordering the flow of data between the various message switchers. It also determines which line discipline is to be used. Full-duplex, half-duplex, polled or contention line discipline capabilities shall be possible.

10.7.1.7 Network Statistics. The STACOM Network shall be capable of collecting statistical data fundamental to the continued efficient use of traffic level prediction and network design tools developed by the STACOM Project.

The STACOM Network shall be capable of collecting the following statistical data:

- Number of messages by message type received from each system termination at State Data Bases.
- Number of messages by message type sent to each system termination from State Data Bases.
- Average message lengths by message type received at State Data Bases.
- Average message lengths by message type sent from State Data Bases.

The STACOM Network shall provide for periodic sampling of the following statistics:

- Origin-Destination message volumes by system termination.
- Percent of "HITS" and "NO-HITS" on each data base type.
- Average waiting times of input messages at switching and data base computers for CPU service.
- Average waiting times of output messages at switching and data base computers for output lines after CPU service.
- Average CPU service time per message at switching and data base computers.
- Total number of messages received each hour at the State Data Bases.
- Total response time for data base interrogations/updates of selected system terminations.

271

10.7.1.8 Operator Interface. The regional switcher shall provide means of interfacing with the operator. This interface shall be used to control and monitor the regional switcher and its network. The following functions are to be provided:

- The regional switcher shall provide a set of commands for the purpose of communicating with the operator.
- The regional switcher shall provide means of outputting data to the operator at a rate of at least 30 characters per second.
- The regional switcher shall provide means of accepting operator control input.
- The regional switcher shall provide high speed data output capability. This data output capability shall not be less than 300 lines per minute. A line shall have 132 characters.

10.7.1.9 Fault Isolation. Regional Switching facilities shall be equipped to rapidly isolate network component faults to the level of lines, modems, communication front ends and switching computers.

10.7.1.10 Switchers with Data Base. RSCs with data base capability employ the additional function of providing file search and update capability. This function involves receiving messages from the switchers message control and routing function (see 10.2.4.1.), and placing their pointers in queue by priority for access to data base files. Upon completion of data base access, messages are returned to the message control and routing function in preparation for output.

RCSs with data bases shall maintain redundant data base files, each of which is updated in parallel at the time of file update.

10.8 NETWORK AVAILABILITY GOAL

The availability goal for the STACOM Network shall be 0.9722 for the worst case Origin-Destination, (O-D), pair of system terminations on the network. The worst case O-D pair is defined as that link from system termination to data base computer that employs the largest number of system components in its path, or the one that is most vulnerable to failure.

Availability of 0.9722 implies an average outage of less than or equal to 40.0 minutes per day for the worst case path. Planned system outage shall be in addition to outages specified here. It shall be a design goal to allocate a minimum of 20 minutes outage per day, (Availability = 0.9861), to data base computers and the remaining maximum of 20 minutes outage per day to terminals, lines, modems and RSCs.

10.9 TRAFFIC VOLUMES

The STACOM Network shall be designed to handle traffic projections through the year 1986. These projections shall include traffic estimates plus design margins for peak vs. average loading. The total network throughput projected from 1977 to 1986 is as follows:

Total STACOM Network Throughput Average Messages/Day (in 1000s)

Year	TLETS	New Data Types
1977	138	8
1981	247	24
1985	311	86

10.10 CONSTRAINTS AND BOUNDARIES

10.10.1 Data Handling Constraints

All data transmission shall be digital.

No unscrambling or decryption shall be performed within the STACOM Network. (Some modems perform scrambling in the normal course of their operation but this scrambling is transparent to the user.)

Traffic loading by network users in excess of the traffic safety margins for which their system terminations are designed could result in degraded message response time.

10.10.2 Data Rate Constraints

The minimum service goal for the STACOM/TEXAS Network shall be 1200 Baud half duplex lines. All available line capacity services above this rate shall be eligible for consideration in a cost/performance effective manner.

10.10.3 Security and Privacy Constraints

The STACOM Network shall be configured to allow management control by an authorized criminal justice agency or group of such agencies. Only STACOM Network operating personnel who have been authorized by STACOM Network Management shall have physical access to the network equipment. These personnel shall have been thoroughly screened. It shall be the responsibility of the STACOM Network Management to institute and maintain security measures and procedures consistent with applicable regulations.

It shall be the responsibility of the STACOM Network Management to ensure that unauthorized personnel are not allowed access by system terminations and that authorized personnel do not employ the network facilities for any purpose other than those for which the STACOM Network is specifically intended.

STACOM Network design shall assist in the realization of adequate security to the extent that engineering considerations can contribute. The STACOM Network shall consider in its design methods to prevent any alterations of the content of messages once they have been routed over the network. All of the equipment comprising the STACOM Network, except for the communication lines, shall provide adequate physical security to protect them against any unauthorized personnel gaining access to the STACOM Network. The computers and other network accessing equipment comprising the STACOM Network shall be located in controlled facilities. Redundant elements should be configured such that a single act of sabotage will not disable both redundant elements.

SECTION 11

ANALYSIS OF EXISTING NETWORKS IN TEXAS

The purpose of this section is to compare the performance of the existing Texas Law Enforcement Telecommunications Network, (TLETS), with network specifications contained in the STACOM Functional Requirements for the State of Texas presented in Section 10.

This section begins with an overview of the present TLETS system. Section 11.2 summarizes areas in which the present system fails to meet stated Functional Requirements, and presents a detailed analysis of the present system in these specific deficient areas.

11.1 THE PRESENT TLETS NETWORK

The analysis of the present Texas Law Enforcement Telecommunications Network, (TLETS), presented here considers service to 431 law enforcement agencies throughout the state consisting of police departments, sheriffs offices and State Department of Public Safety, (DPS), offices. The network is managed by the DPS.

The TLETS network is topologically distributed from three regional switching centers located in Garland, Austin, and San Antonio. Terminals on the network are served from these switchers by 75, 110, or 1200 Baud multidropped lines.

Network users have access through the Austin switcher to state data bases located in Austin consisting of the Texas Crime Information Center, (TCIC), a drivers record system, (LIDR), and the Motor Vehicle Department, (MVD), records.

Figure 11-1 presents a simplified diagram of the TLETS system. Detailed TLETS line layouts for 75, 110, 1200, and 2400 Baud lines are shown in Figures 11-2 and 11-3.

In general, multidropped lines are organized such that terminals on a given drop are clustered in areas under the jurisdiction of a single Council of Government, (COG). There are approximately 24 such COGs in the state of Texas as depicted in Figure 11-4. Figure 11-5 presents a composite of Figures 11-2 and 11-3 showing the complete TLETS terminal network.

The Garland and Austin switchers communicate through two 2400 Baud lines and the San Antonio Switcher is connected to the Austin switcher through a single 2400 Baud line.

The Austin switcher also provides for TLETS communication with the NLETS switcher in Phoenix through a 2400 Baud line and with the NCIC through a 2400 Baud line.

275

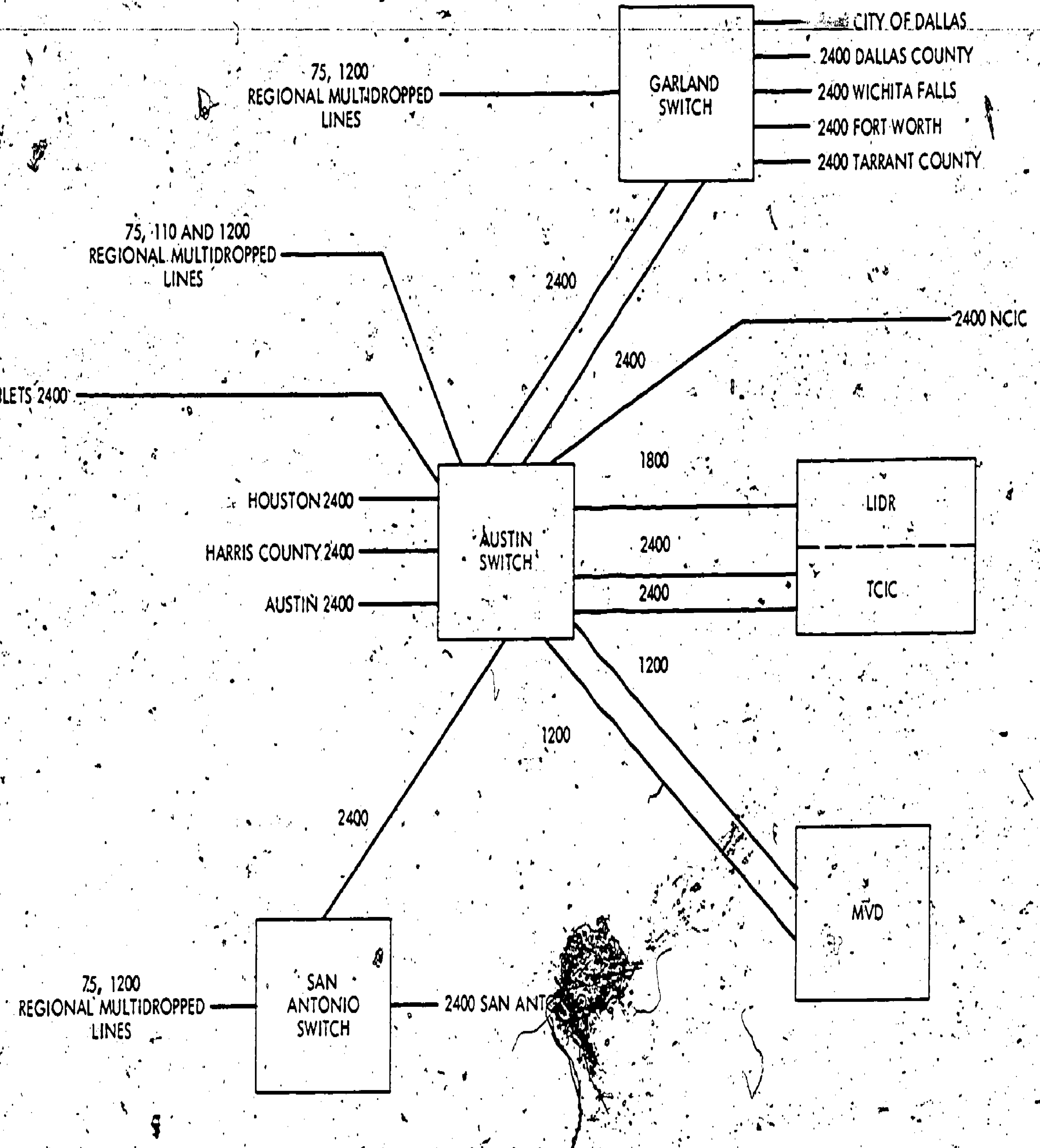


Figure 11-1. Simplified TLETS Diagram

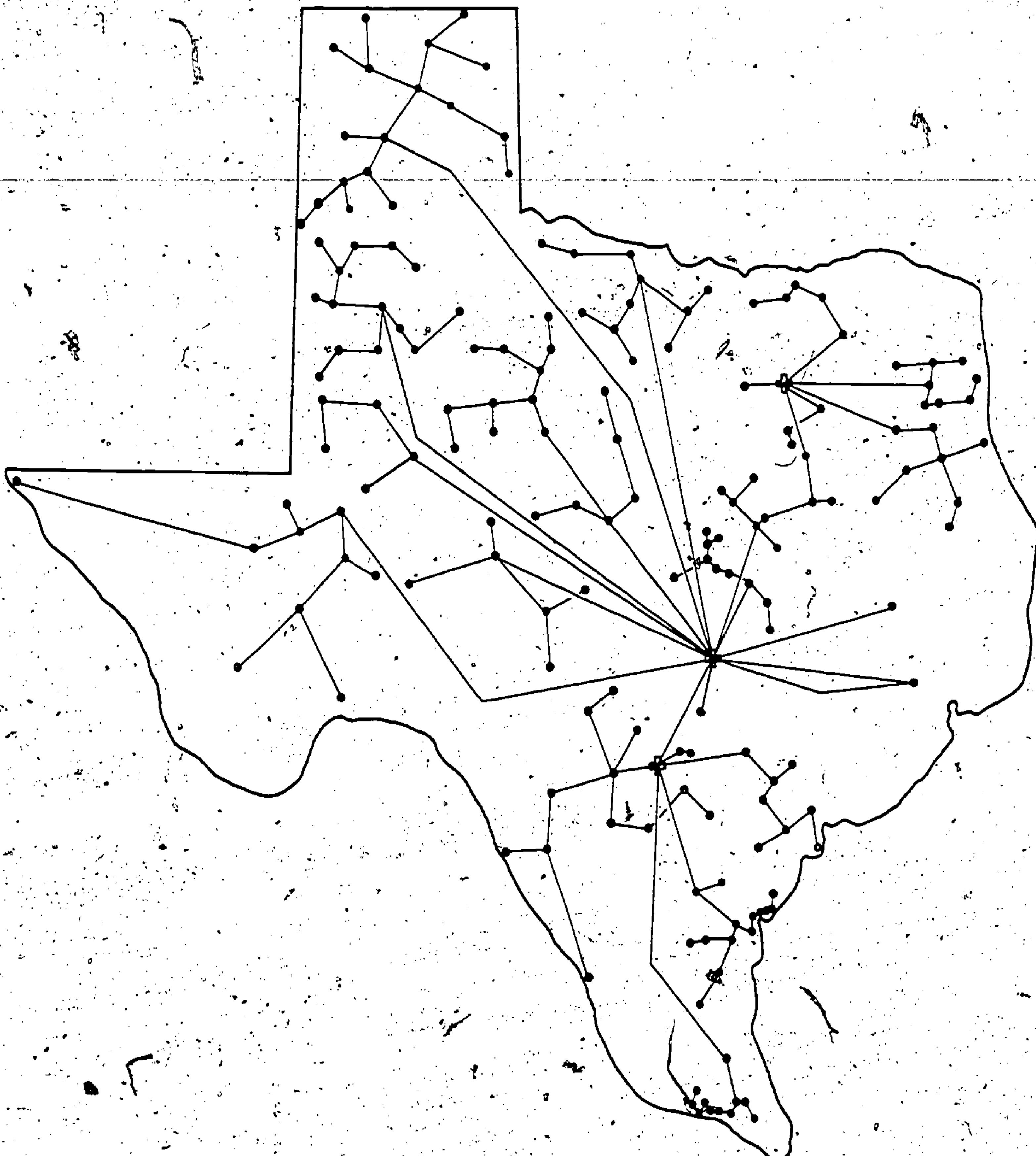


Figure 11-2. TLETS -- 75 Baud Lines

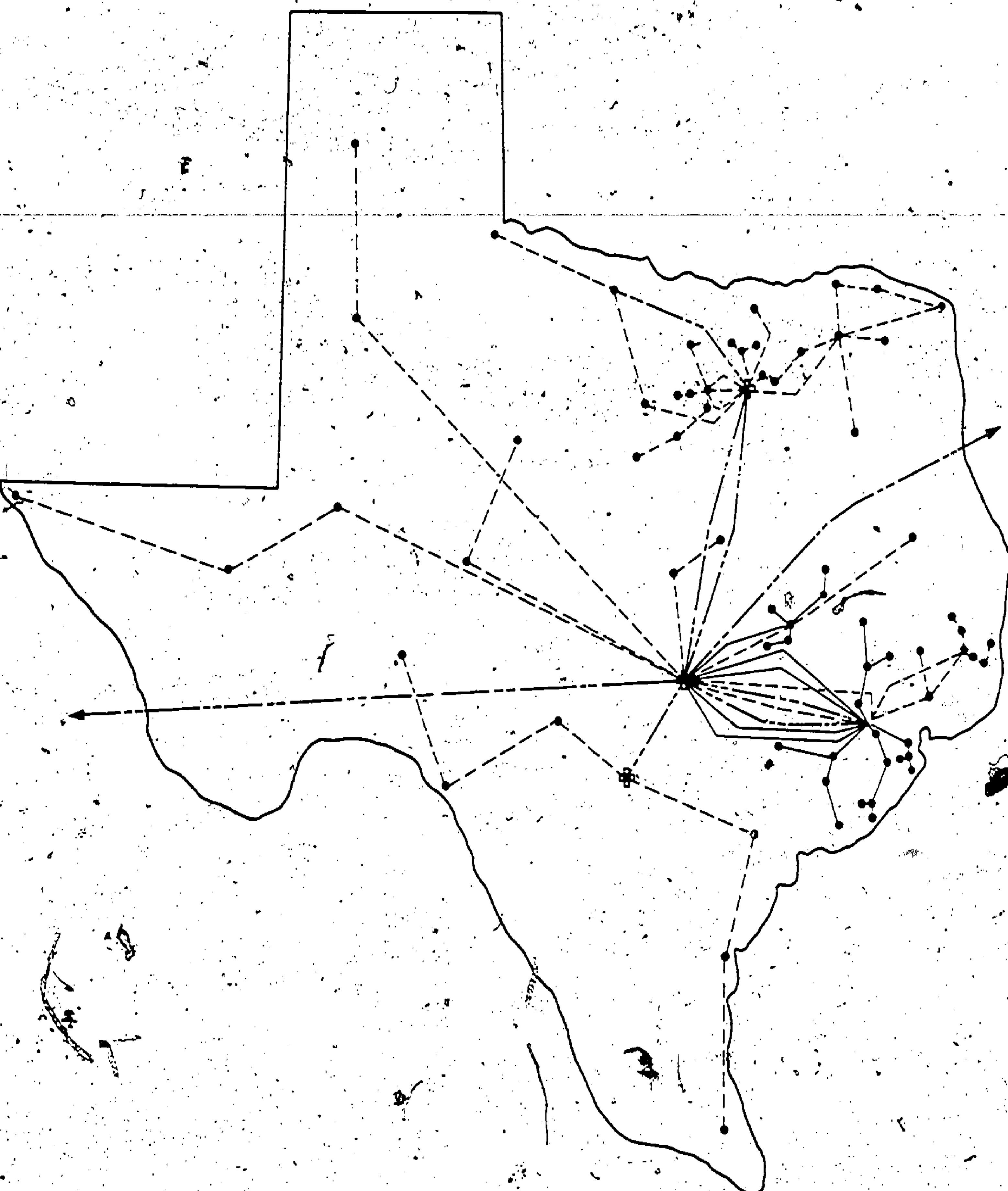


Figure 11-3. TLETS 110, 1200, 2400 Baud Lines

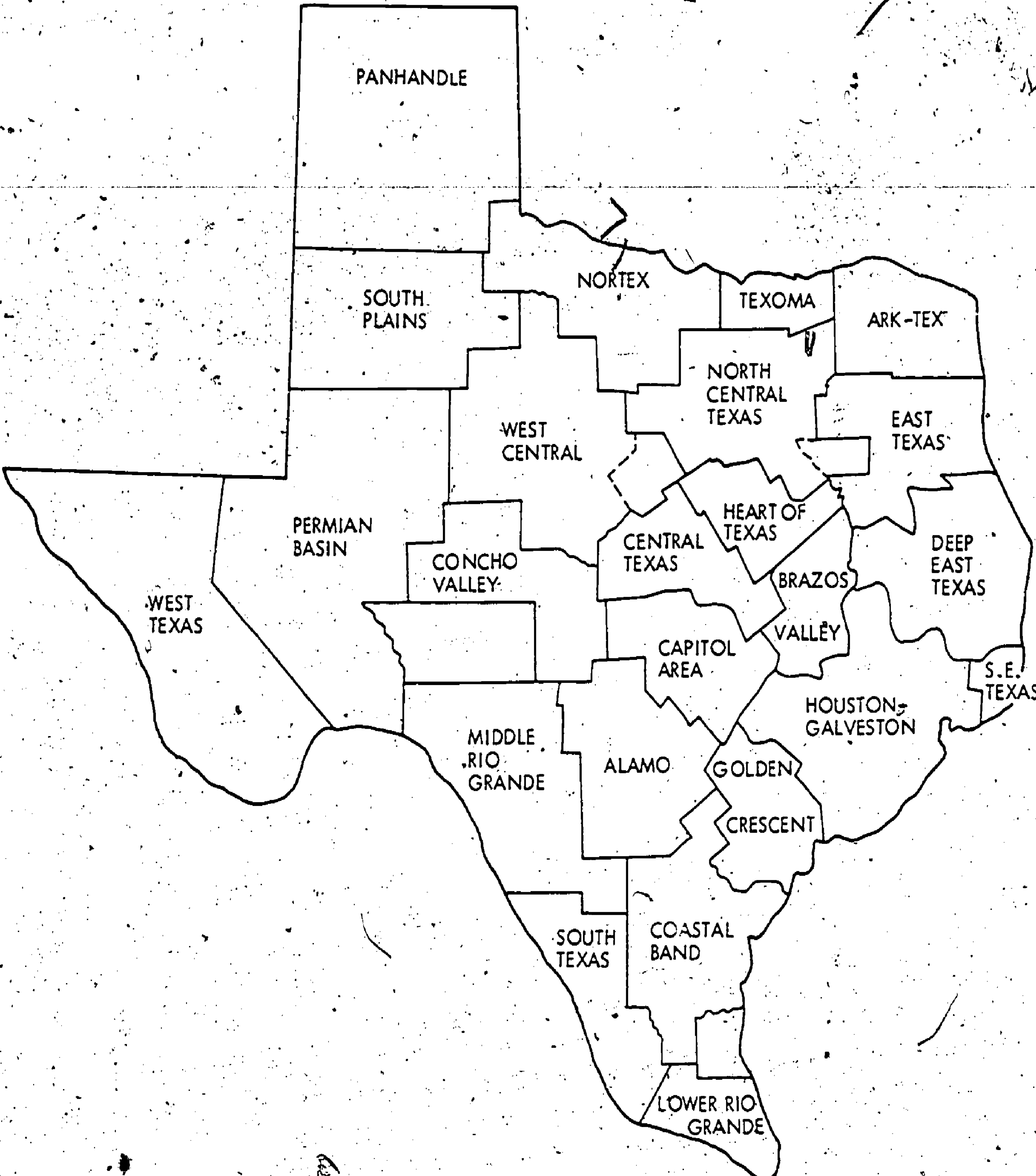


Figure 11-4. Texas Council of Governments

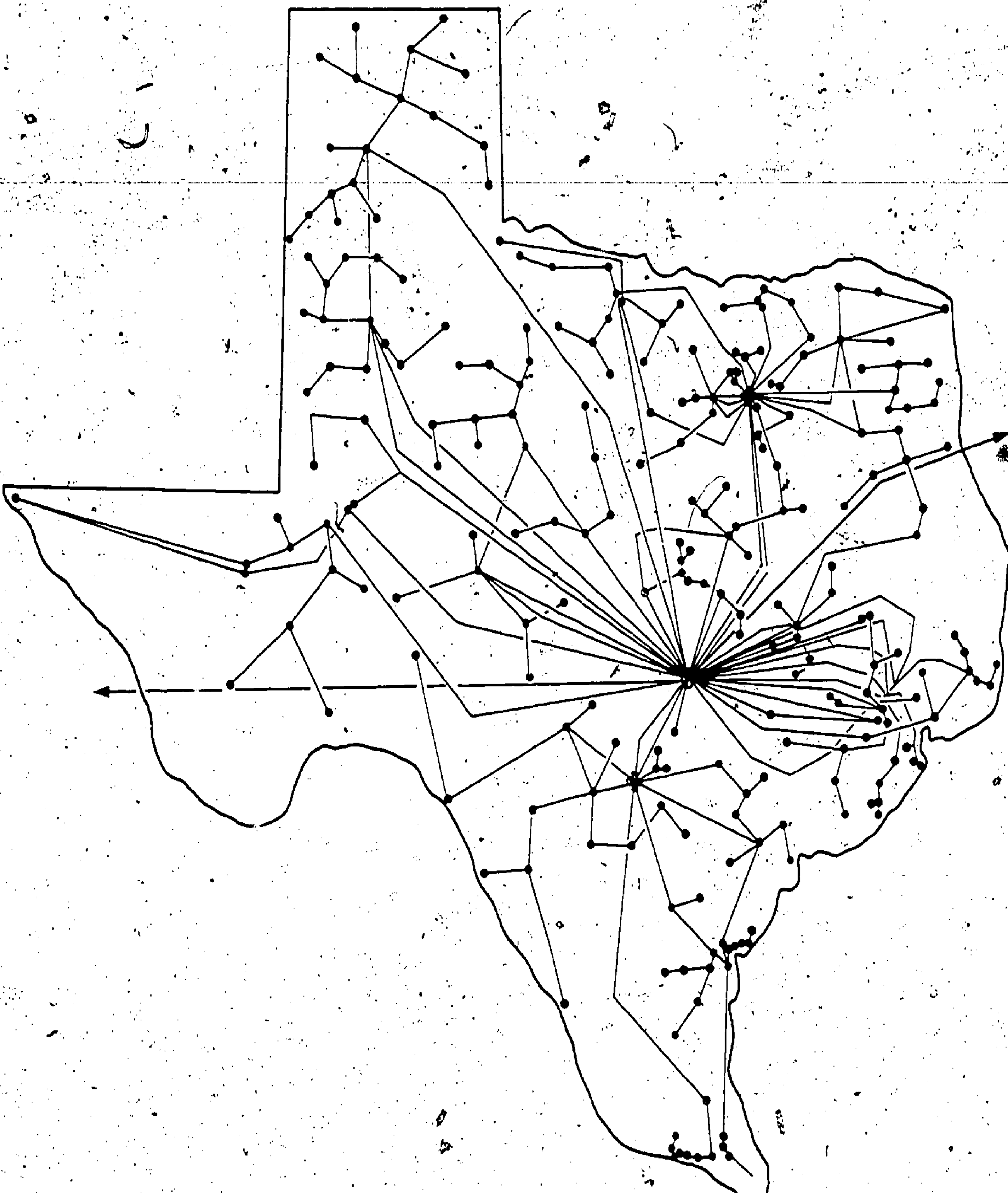


Figure 11-5. TLETS Lines

The Austin switcher is connected to the TCIC data base through two 2400 Baud lines, to the LIDR data base through a single 1800 Baud line and to the MVD data base through two 1200 Baud lines. In the present system, the data base lines are held once an inquiry is initiated from the Austin switch until the response is returned over the same line.

The TCIC data base computer is an IBM 370/155 and the MVD employs two 370/155's. The three TLETS switchers are supplied by Action Communication Systems of Dallas, Texas.

The total cost of TLETS lines, modems, service terminal arrangements and drop charges is $320,000 per year. These costs include charges to central COG points and charges incurred within COG's.

It is anticipated that total network costs for lines, modems, service terminals and drop charges for the present network with a minimum line service of 1200 Baud would cost approximately $495,000 year.

11.2 COMPARISONS OF EXISTING NETWORK WITH STACOM/TEXAS FUNCTIONAL REQUIREMENTS

Table 11-1 summarizes conformity to STACOM/TEXAS Functional Requirements by the existing TLETS Network.

The two principal areas for discrepancies shown are Network Response Times and Network Availability. The following sections discuss these deviations in detail.

11.2.1 Response Times

Response time for the STACOM Network is defined as the time duration between the initiation of a request for service for an inquiry message at a network system termination and the time at which a response is completed at the inquiring system termination.

The response time goal for the STACOM Network for law enforcement traffic is to achieve a mean response time less than or equal to 9 seconds, which insures that 90% of the time, responses to inquiries shall be received in less than 20 seconds.

Response times at given terminals on the TLETS Network depend on the number of switchers that messages must pass through to and from the data bases, and on the line speed servicing the terminal on a multidrop.

Representative circuits at each multidrop line speed, (75, 110, and 1200 Baud), that carry relatively heavy loads of traffic were selected for analysis. Circuits selected for analysis were the Garland circuit 4 at 75 Baud, the Austin circuit 27 at 110 Baud and the Garland circuit 15 at 1200 Baud. Normally, in a worst case analysis, circuits would be selected that pass through the maximum number of switchers - in the Texas case, two. Austin circuit 27 was selected at 110 Baud because there are

Table 11-1. Conformity Summary of Existing Network to STACOM Functional Requirements

Requirement	Section X Requirements Met	Section X Requirements Not Met
Message Characteristics	All	-
Network Message Handling	Routing, Protocol, Coding, Error Detection, Status Messages	Response Time on 75, 110 Baud Lines
System Terminations	All	-
Regional Switching Centers	Dallas, San Antonio	Austin Switch Mean Service Time
Network Availability Goal	-	TCIC/LIDR Data Base Availability
Traffic Volumes	Average Traffic Levels	Peak Traffic Levels
Constraints and Boundaries	Data Handling	Data Rates

no 110 Baud lines in the present system served by the Garland or San Antonio Switchers. Garland circuits 4 and 15 were selected for analysis because their traffic loads are higher than any 75 or 1200 Baud lines served through the San Antonio switcher. These circuits, then, are representative of worst case performance for 75, 110, and 1200 Baud multidrops on the network.

Response times at terminals presented here are estimated mean values derived from queueing equations presented in Section 2 of this report.

The solid line in Figure 11-6 presents mean response time for the Garland circuit 15. At a 1977 average daily traffic level taken to be 116,000 transactions per day through the Austin switcher, the system performs adequately with a mean response time of 8.6 seconds. However, at system peak loads, estimated at twice the daily average, response time becomes excessive. Queueing analysis indicates that the principal contributor to this excessive response time at user terminals is the buildup of queues at the Austin switcher. This component of total response time is shown by the dotted line in Figure 11-6. With the present mean service time per transaction estimated at 400 ms for the Austin switch, computer utilization of 0.7 is reached at a transaction level of 151,000 per day, as shown in Figure 11-6. In general, telecommunication systems should be designed such that switcher utilizations do not exceed 0.70.

Figure 11-7 presents system queue times for circuit 15 at selected system traffic levels. It can be seen that the Austin switch

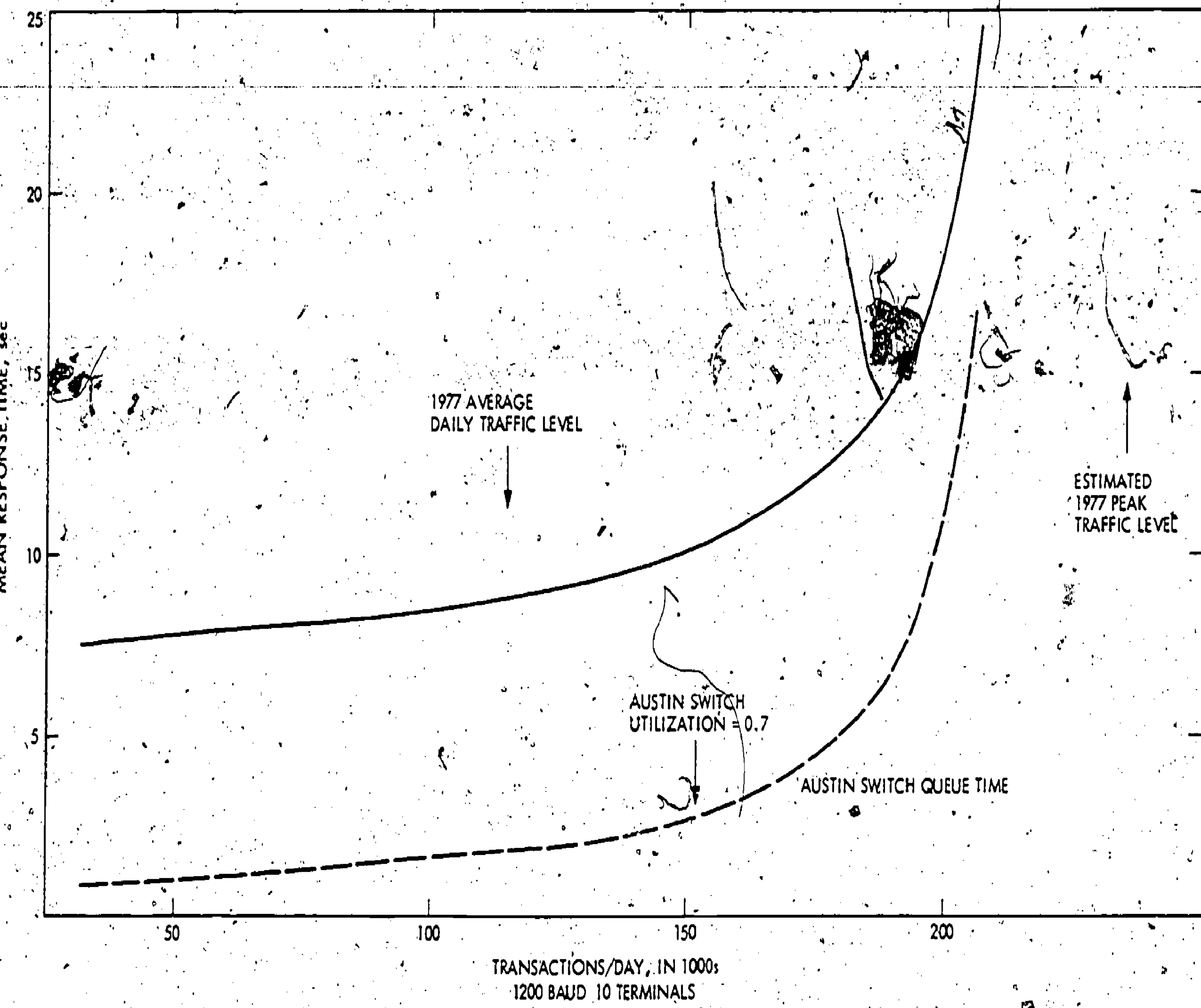
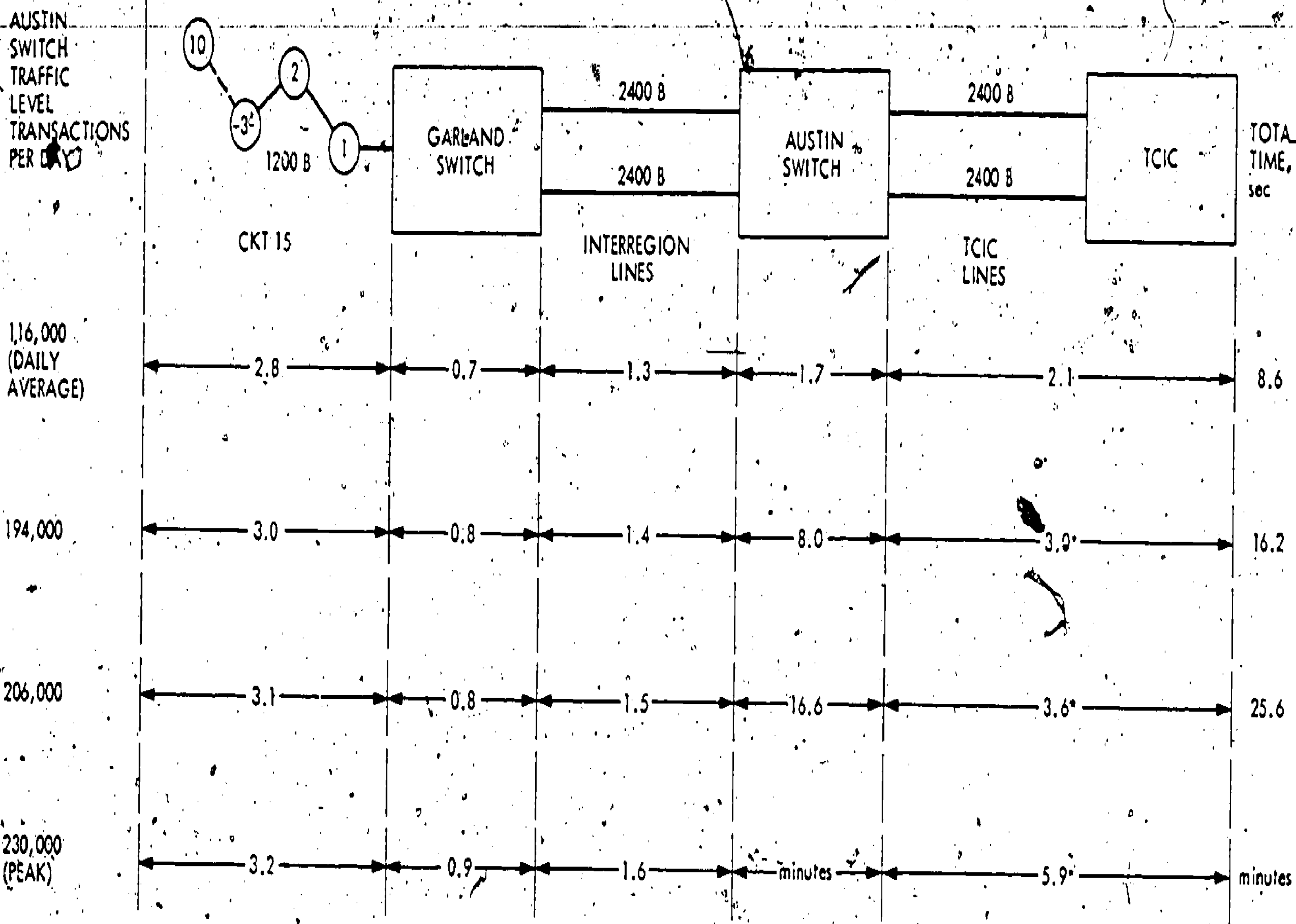


Figure 11-6. Mean Response Time to TCIC Garland CKT 15



*RESPONSE TIME AT IN-HOUSE DPS DATA ENTRY TERMINALS DEGRADED.

Figure 11-7. Time Spent in Seconds in System Components as a Function of Traffic Levels for TCIC component becomes excessive as traffic progresses from average levels to peak levels, whereas the remaining components consisting of the multidrop line, the Garland switch, interregion lines and the TCIC do not increase as dramatically.

Figures 11-8 and 11-9 present mean response times at terminals on Garland circuit 4, (75 Baud) and Austin circuit 27 (110 Baud). The major component of times in these cases is spent in transmitting over the low speed multidropped lines. It is interesting to note that the 110 Baud line out of Austin actually has a longer response time at terminals than the 75 Baud line out of Garland, even though the latter passes through an additional switcher. There are four principal reasons for this - (1) 110 and 75 Baud lines have the same character rates*, (2) the 110 Baud line protocol involves more line turnarounds per message, (3) the traffic level on circuit 27 is higher than on circuit 4, and (4) there are 15 terminals on circuit 27 and only 10 on circuit 4.

In any case, low speed lines exhibit response times on the order of one minute during average network transaction levels and of minutes to tens of minutes during network peak transaction levels. The low speed lines themselves are major contributors to response time at low traffic levels and the Austin switch is the limiting factor at higher levels.

It is also of interest to consider the effect of peak traffic levels on the TCIC/LIDR and MVD computers. In the case of the TCIC/LIDR 370/155, an exact analysis is made more difficult because traffic levels from DPS in-house data entry terminals, (DPS traffic), must be estimated during TLETS average and peak traffic levels. On any given day DPS traffic peaks may not fluctuate as much as TLETS inquiries to the TCIC and LIDR, however, over a period of years DPS traffic can be expected to grow at approximately 4% per year. The analysis presented here assumes an increase in DPS traffic as TLETS traffic fluctuates, and, in that sense is conservative.

Increases in DPS traffic, of course, affect the TCIC/LIDR computer utilization. The effect of high computer utilization on TLETS inquiries, however, is minimized since these inquiries are given priority over DPS interaction. Thus TCIC/LIDR computer utilizations of up to 0.8 to 0.9 have fairly small effects on TLETS response time, but do have a significant effect on in-house DPS terminal operations, (see Figure 11-7).

Total queue times for an inquiry passing through the Austin switch to the TCIC/LIDR computer and back out through the Austin switch were analyzed as a function of network traffic load. A similar exercise was carried out for the MVD computer. Figure 11-10 shows queueing times for the three data bases including the Austin switch. TCIC is seen to provide the best service and LIDR the longest. The curves are driven

*110 Baud lines have 11 bits per character and 75 Baud lines have 7.5 bits per character; thus both lines transmit 10 characters per second.

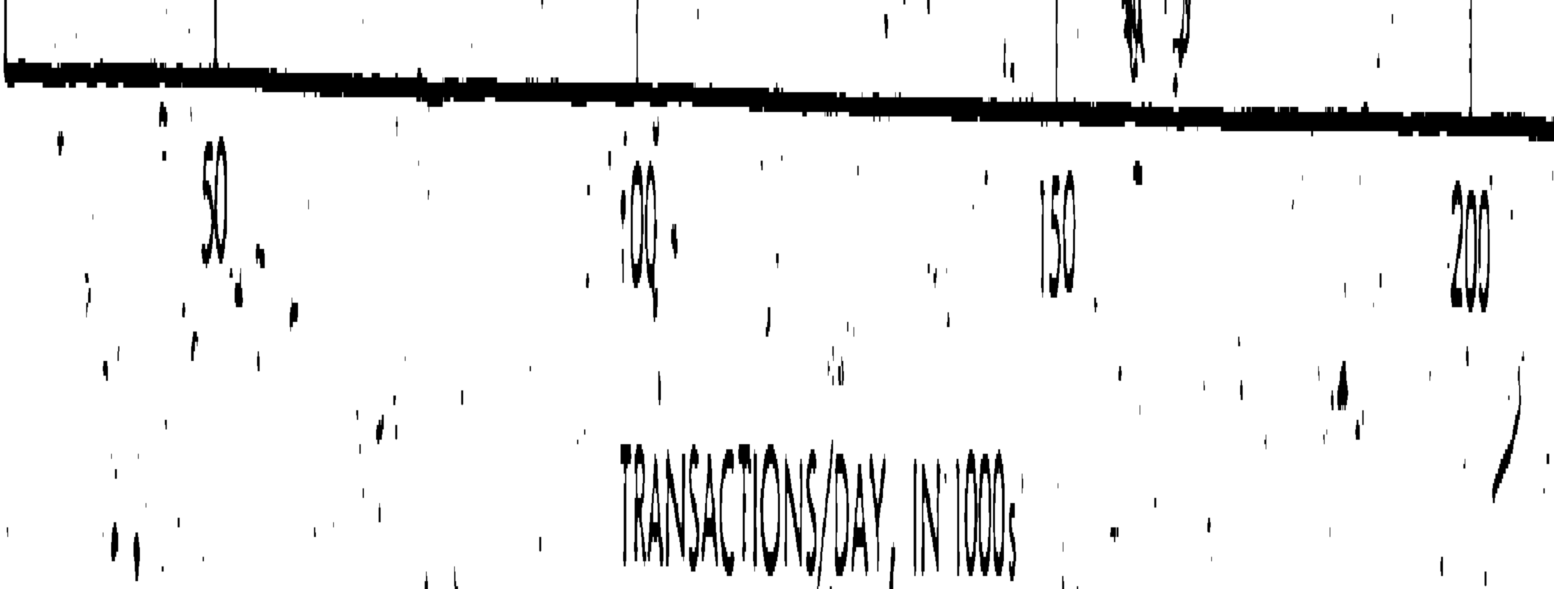


Figure 11-8. TLETS Mean Response Time - 75 Baud Lines

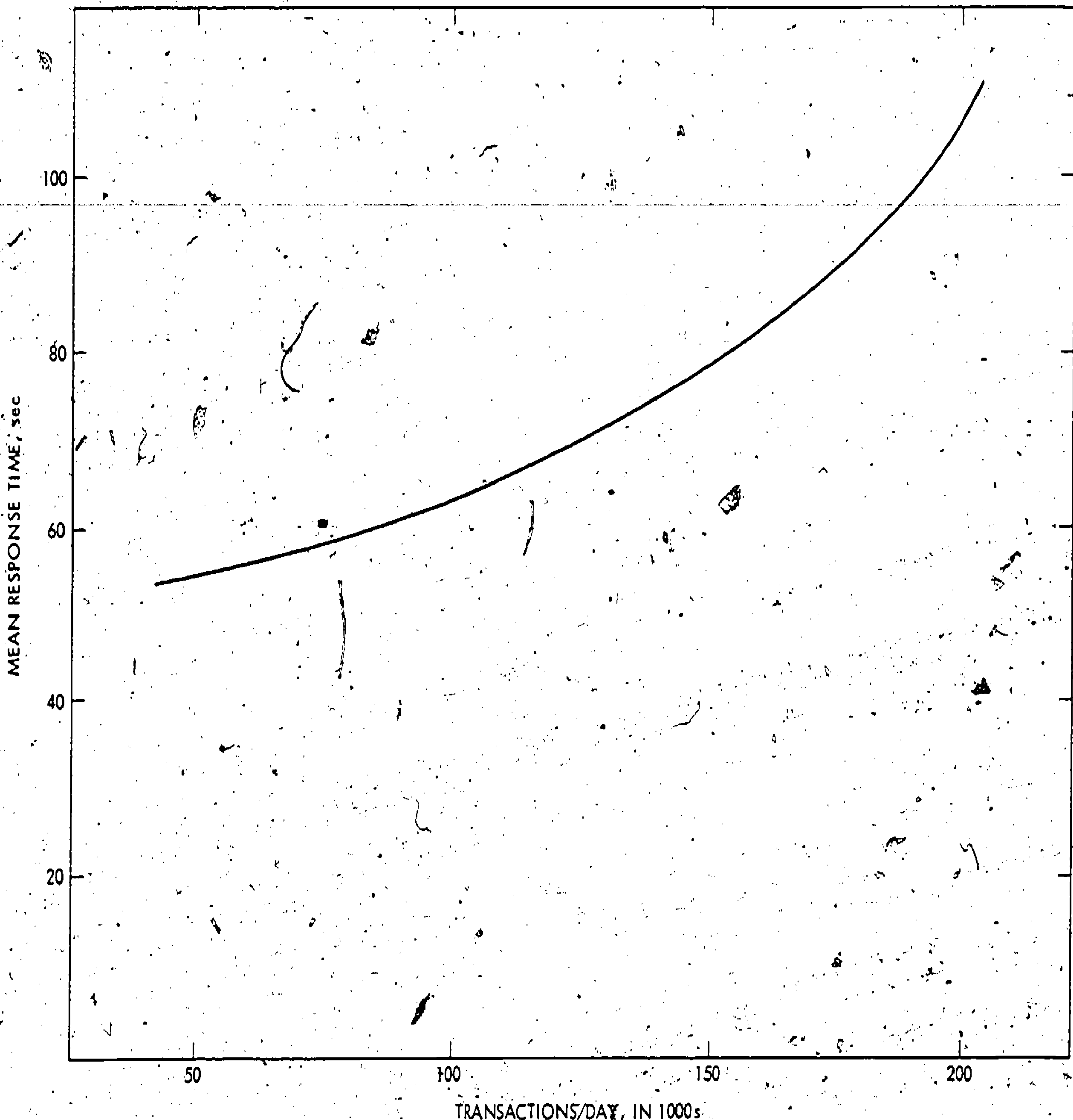


Figure 11-9. TLETS Mean Response Time - 110 Baud Lines

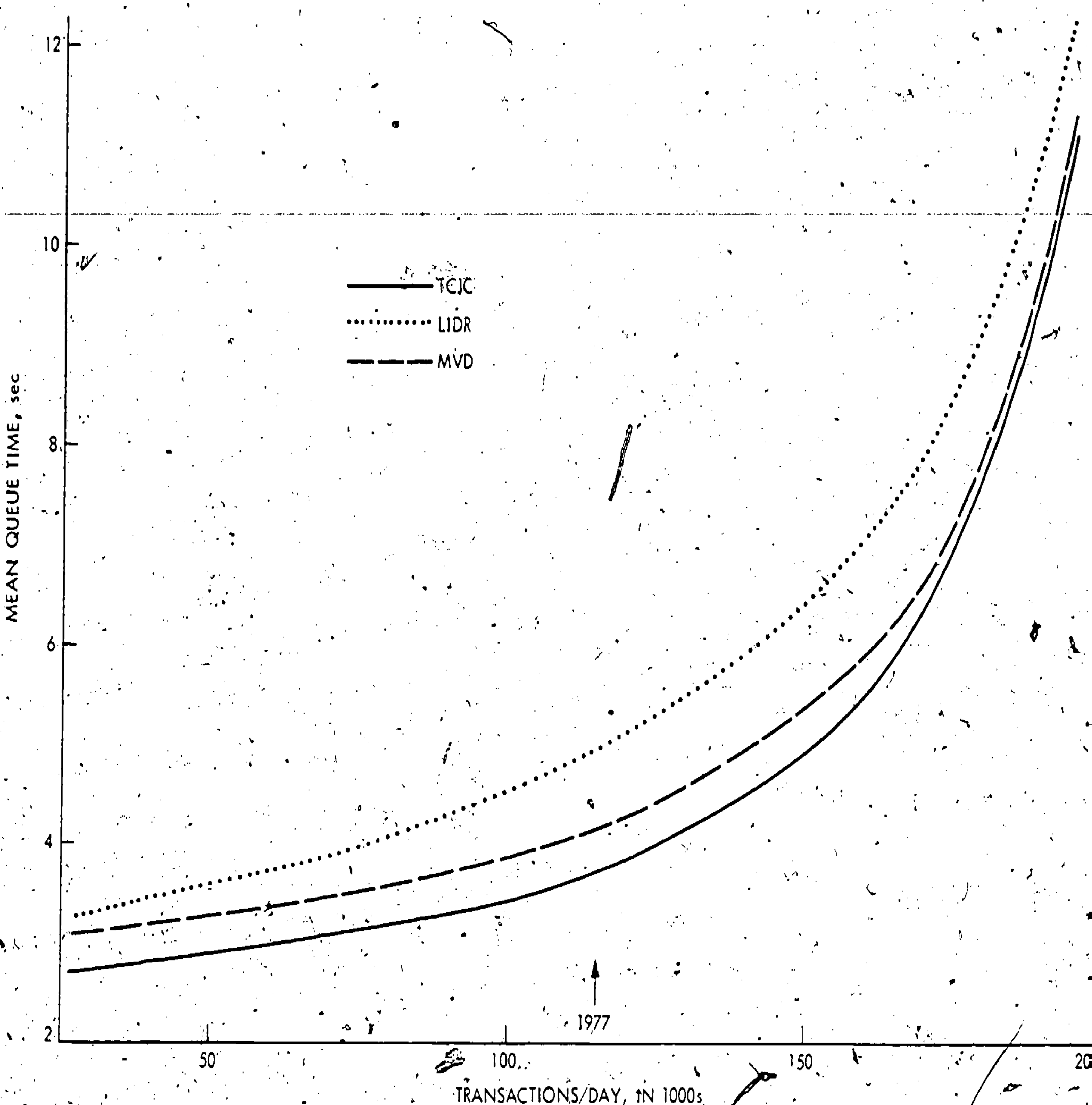


Figure 11-10. Present Data Base System Including Austin Switch

upward as TLETS traffic levels increase because of long queueing in the Austin switch, (high computer utilization).

It is also of interest to estimate the present system performance of the data base systems alone without the effects of the Austin switch. This is shown in Figure 11-11 where data base queue times are presented as they appear to the Austin switch. The TCIC and MVD systems provide better data base turnaround times due to the fact that they provide service over two lines. However, it is also noted that these systems begin to degrade rapidly at TLETS peak traffic levels which adds to response time degradation at DPS terminals under our conservative assumption.

From the standpoint of network response time at user terminals, then, we can conclude the following with respect to the present TLETS system.

- 75 and 110 Baud lines do not meet functional requirements due to their inherent low data rates.
- 1200 Baud line service mean response time is less than or equal to 9 sec., (the functional requirements goal), for traffic levels of under 130,000 transactions per day at the Austin switcher, (see Figure 11-6).
- Network response time limitations encountered above 130,000 transactions per day are due principally to high utilization of the Austin switch.
- The TCIC/LIDR computer also experiences utilizations near 0.9 at network peak traffic levels.
- During peak traffic loads on the present TLETS system, the magnitude of user response times at terminals is measured in minutes to tens of minutes.

Section 12 of this report treats specific network and computer upgrades required to meet the STACOM/TEXAS Functional Requirements of Section 10.

11.2.2 Network Availability

In Paragraph 7-2 of this report, sample calculations are carried out which derive system reliability and availability for the present TLETS System. These calculations show that the system availability for a terminal connected through the Dallas regional switcher is 0.915. This value implies an average daily outage of the network to any terminal connected to the Dallas switcher of 122 minutes.

A similar calculation carried out in Paragraph 7-2 for terminals connected through the San Antonio switcher results in an availability of 0.915 which implies an average daily outage of 134 minutes.

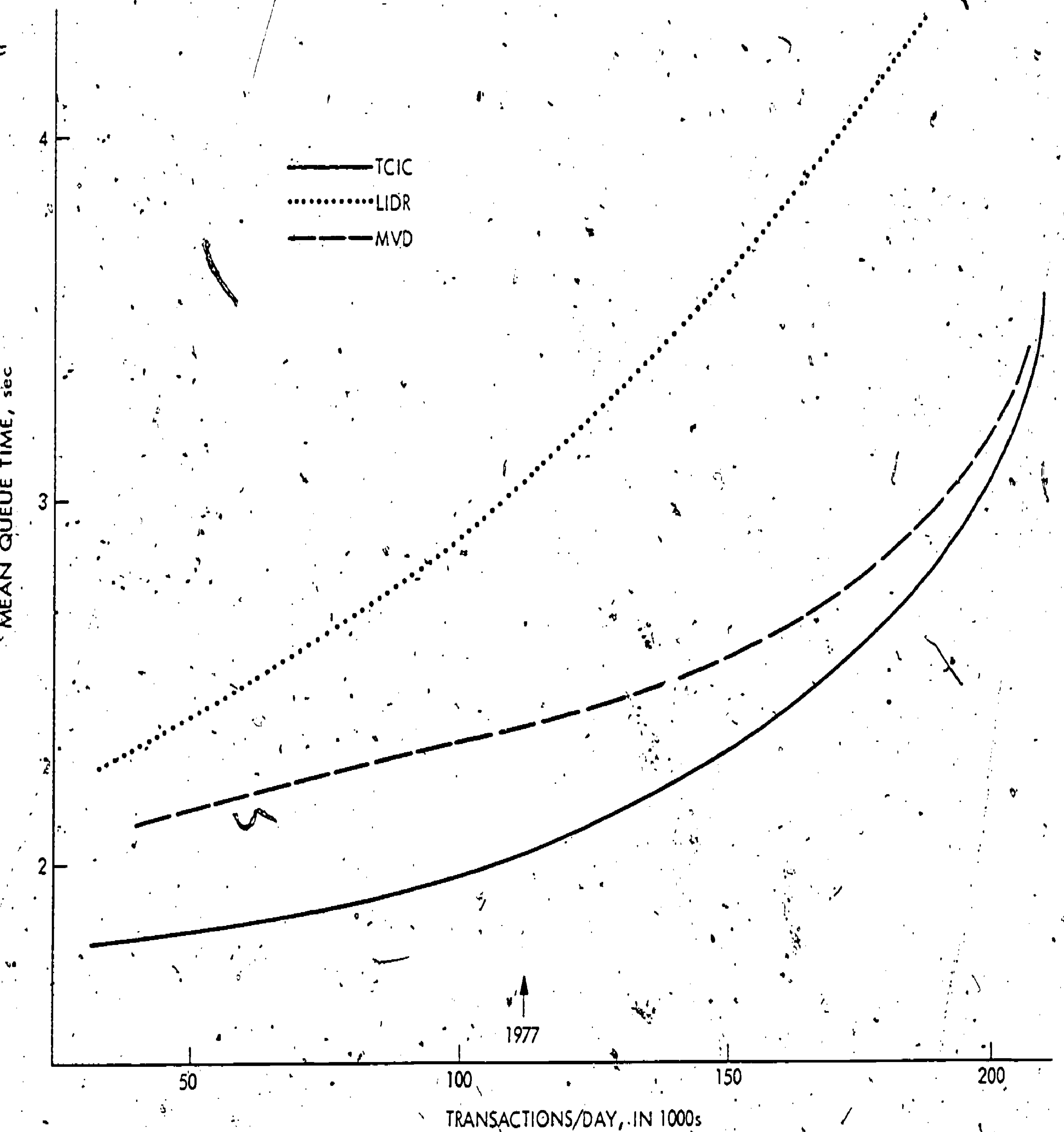


Figure 11-11. Present Data Base System Not Including Austin Switch

The Functional Requirements for the State of Texas set an availability goal of 0.9722 which corresponds to an average daily outage of 40 minutes. Thus, the present network does not conform to availability goals. Specific upgrades required for conformity are discussed in Section 12.

SECTION 12

NEW OR IMPROVED STACOM/TEXAS NETWORKS

This section presents detailed topology, cost, and performance data for each of the network options outlined in Section 8. Section 13 of this report presents a comparative discussion of cost and performance data for the options considered.

12.1 COMPUTER PERFORMANCE REQUIREMENTS

12.1.1 Mean Service Time Upgraded

STACOM/TEXAS networks are designed to meet response time functional requirements for all network options at peak network traffic loads. To this end, computer mean service times per transaction at peak traffic loads have been assumed such that switcher and data base computer utilizations do not exceed values in the neighborhood of .700. It is important to realize that increasing network multidropped line speeds does not appreciably decrease network response times when computer utilization becomes high, i.e., increasing line speeds is not an effective solution for alleviating computer queueing pressure. Thus, it is of crucial importance to maintain computer utilizations at less than approximately 0.700 at all times.

The networks presented in this section assume similar data base line and computer configurations as exist now in Austin, with certain specific upgrades.

Specifically, the Austin Switcher serves the TCIC through two lines, the LIDR through one line and the MVD through two lines as in the present system. The line "holding" procedures in present use with the TCIC and MVD are maintained.

Table 12-1 summarizes traffic loads on the Austin Switcher, the TCIC/LIDR data base and the MVD data base in terms of computer transactions in 1981 and 1985. Also included are transaction requirements for handling new data types. The following comments discuss the origins of values entered in the table.

Values shown for transactions at the Austin Switch include the total of existing TLETS traffic types plus CCH, new data types and fingerprint traffic. The TCIC and LIDR entries show predicted levels for these data bases. The TCIC levels include CCH traffic. That is, it is assumed that CCH in Texas will continue to be implemented at the TCIC/LIDR data base.

Values shown for in-house data processing traffic on the TCIC/LIDR computer assume a growth of 4% per year from 1977 levels through 1985.

Table 12-1. Traffic Loads on Computers by Year

	1981			1985		
	Av Trans Per Day (1000)	Av Trans Per Sec	Peak Trans Per Sec	Av Trans Per Day (1000)	Av Trans Per Sec	Peak Trans Per Sec
Austin Switch	230	2.66	5.32	315	3.6	7.2
TCIC	43	0.5	1.0	47	0.55	1.1
LIDR	10	0.12	0.23	13	0.15	0.3
In House DP Terminals	65	0.75	1.5	74	0.86	1.75
MVD from Austin Switch	24	0.28	0.56	30	0.35	0.70
MVD other Processing	7	0.08	0.16	8	0.09	0.18
New Data Computer	15	0.17	0.35	25	0.29	0.58

Traffic shown between the Austin Switch and the MVD computer is taken from STACOM/TEXAS MVD traffic predictions. The MVD computer also handles traffic from sources other than the Austin Switch. This traffic is assumed to amount to 25% of the Austin Switcher MVD traffic level.

Finally, it is assumed, and recommended, that new data types be integrated onto a single separate computer facility located in Austin. These data types include systems used by ICR, OBSCIS, SJIS, fingerprints, TYC, Pardons and Paroles, and Corrections.

The traffic levels shown in Table 12-1 were run through data base queueing models discussed in Section 7 of this report in order to size data base line and computer mean service time requirements. Table 12-2 summarizes the results of that analysis.

It is recommended that all data base lines be immediately upgraded to 4800 Baud lines. This upgrade will be sufficient to meet line requirements from the present through 1985. An investigation into the merits of "holding" or not holding TCIC/LIDR and MVD lines was carried out. It was found that holding the lines, as is the present practice, is a bad practice only when line utilizations become excessive. Since data base lines need to be upgraded to 4800 Baud in any case, the penalty for

Table 12-2. Computer Mean Service Time and Data Base Line Requirements for Peak Loading

Years	Line Requirements in Baud - Austin Switch to Data Base			Required Mean Service Time per Transaction (ms)			
	TCIC	LIDR	MVD	Austin Switcher	TCIC/LIDR	MVD	New Data Computer
1977 to 1980	4800 (2)	4800 (1)	4800 (2)	130	250	400	2000
1981 to 1985	4800 (2)	4800 (1)	4800 (2)	100	200	400	1500

continuing the present practice is minimized to an extent that response time functional requirements can still easily be met.

Computer upgrade requirements in terms of mean service time per transaction is also indicated in Table 12-2. To function properly, the Austin switcher should immediately be upgraded to perform with a mean service time of 130 ms, and, in 1981, should exhibit a mean service time of 100 ms. As an example, the Action Model 200 system with the Nova Model 840 and Century Discs could meet these requirements.

The TCIC/LIDR computer should immediately be upgraded to provide a mean service time of 250 ms, and in 1981, provide a mean service of 200 ms. The 250 ms goal may be approached by considering the use of an IBM 370/158 machine and 3350 Discs with a reduction of mean disc accesses per transaction from 8 to 6. The 200 ms goal may require a mixed use of totally fixed head discs and semi-fixed head discs. At this point, improvements in CPU time per transaction will not appreciably reduce total mean service time per transaction.

The MVD computer need not be upgraded through 1985. A mean service time of 400 ms will continue to serve that data base adequately.

The networks presented in this section assume that the data base line and computer upgrades outlined above will be carried out as indicated.

12.1.2 System Availability Upgrade Requirements

The principal component which causes non-conformity to STACOM/TEXAS Functional Requirements for system availability is the TCIC/LIDR data base computer. If the availability of this facility is upgraded to 0.9814, system availability requirements can be met for the single region case. The following characteristics provide an example as to how this might be achieved:

- MTBF 145 hours
- MTTR 1.7 hours
- Failure Rate (X 10-3) 6.88
- Availability 0.9814

If these conditions are met, the resulting availability of the single region TLETS Network would be 0.974 which implies an average daily system outage from any terminal on the network of 37.4 minutes. The STACOM/TEXAS goal for availability implies an average daily average outage of 40.0 minutes.

For multiple region configurations, upgrades are also required at regional switching sites to improve system availability. In multiple region configurations, availability of regional switchers should be 0.997 in addition to the above mentioned data base improvement. By way of example, this goal could be achieved with;

- MTBF 333 hours
- MTTR 1 hour
- Failure Rate (X 10-3) 3.0
- Availability 0.997

These improvements will yield a network system availability of 0.973 which corresponds to an average daily system outage of 39 minutes.

12.2 OPTION 1 - SINGLE REGION TLETS

12.2.1 Topology

The STACOM/TEXAS single region TLETS network layout is shown in Figure 12-1. The network consists of a single regional switcher facility located in Austin connected to the TCIC/LIDR and MVD Data Bases. There are 35 multidropped lines serving system terminations. All network lines are 1200 Baud lines with the exception of one 2400 Baud line and

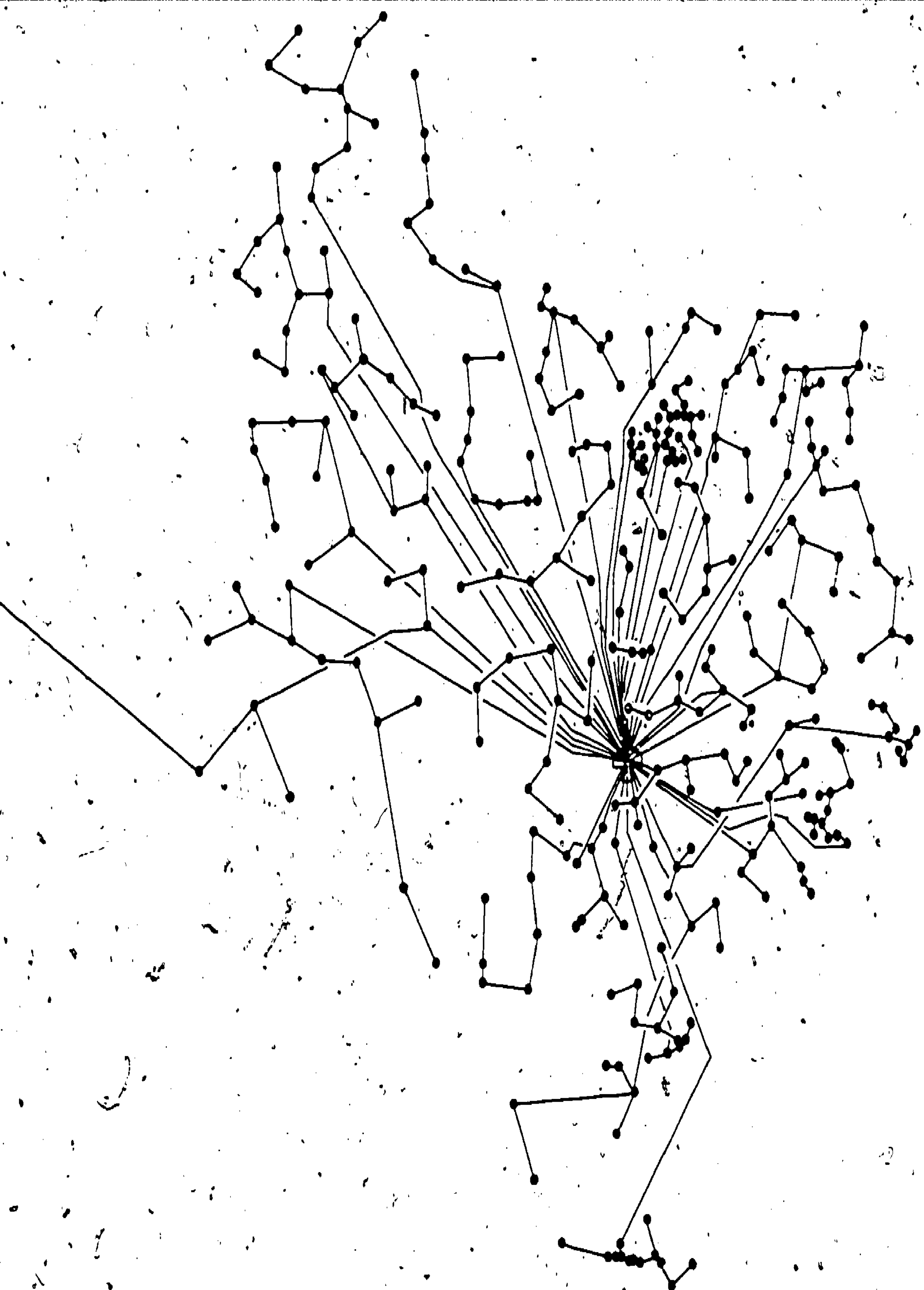


Figure 12-1. Single Region TLETS Network

one 4800 Baud line. Table 12-3 presents the detailed terminal assignments for each of the 35 multidrops. Reading from left to right, the Table shows the line number, (1 to 35), the total number of terminals on the drop, the alphabetic code name for the first terminal on the drop, and the remaining code names for terminals on the drop in order.

12.2.2 Costs

Total eight-year costs for the single region TLETS system are presented in Table 12-4. Total costs based on costing assumptions outlined in Section 11 amount to $15,800,000. About 68% of this total cost is due to terminal recurring and purchase costs. Lines, modems and service terminals amount to approximately 31% of total costs. Engineering costs make up the remainder. Regional switchers in addition to the Austin Switcher are not required in this option.

12.2.3 Line Performance

Table 12-5 summarizes performance characteristics by line for the single region TLETS Network. Reading from left to right, the table presents the line number, the code name for the first terminal on the drop, the total number of terminals on the drop, the line capacity in Bauds, the peak line utilization value, total mileage on the drop, and the mean response time for any single terminal on the drop.

Mean response times on the single region network run between 2.5 seconds to a worst case value of 8.7 seconds depending on the specific multidrop line. Of the 35 lines in the network, 33 have mean response times of less than 5 seconds.

12.2.4 Network Availability

The availability of the data bases to any terminal on the network is 0.974 calculated in accordance with the procedure outlined in Section 8.2, and assuming data base upgrades called for in Section 12.1.2 are implemented. This availability implies an average network daily outage at any terminal on the network of 37 minutes.

12.3 OPTION 2 - TWO REGION TLETS

12.3.1 Topology

For the STACOM/TEXAS two region case, four possible networks were studied. Each of the four networks consists of one region served by the Austin Switcher. Candidates for a second region in the network included, Dallas, Amarillo, Lubbock, and Midland.

Table 12-3. Terminal Assignments

NETWORK OPTION: TLETS/AUSTIN

NUMBER OF REGIONS: 1

REGION	LINE NO.	TOTAL NO.	TERMINALS STARTING	TERMINALS REMAINING
1	1	10	SXLP	SXFS,S ,SXRJ,SXAT,AZZD,SXQS,SXYA,SXYH,SXQW,
	2	20	AZID	AZIC,AZAV,AUB ,AUH ,AZAV,AZCS,AZFH,AZFW,AZFL,AZZH, AZHN,AZIB,AZTY,AZFK,AZYN,AZSE,AZUJ,AZUK,AZPB,
	3	18	SXQQ	NABD,SXPR,SXSQ,SXKC,NAAD,SXSN,SXLE,NAAF,SXQX,SXRB, NABT,NACW,NARK,SXCC,NAFC,SXQZ,NAEK,
	4	17	AZFI	AZFJ,AU+S,AZFZ,AZHC,AZLZ,AZAW,AZFD,AZIA,AZAN,AZYP, AZFB,AZFE,AZAU,AZIU,AZIU,AZTQ,
	5	19	SXKA	NABX,SXGV,SXDJ,SXDK,SXRQ,SXBR,SXRC,SXRD,NAFB,SXPN, NACS,SXSD,SXBR,NAAK,SXDS,NACN,SXDL,SXDN,
	6	20	SXQP	NACA,SXGC,SXBK,SXRJ,SXBL,SXRT,SXBS,SXYF,NADX,NADN, SXAD,NADW,SXBI,NAAH,SXWT,SXIT,SXBW,NAAC,SXRZ,
	7	20	SXRK	SXRL,SXYJ,NACE,SXDA,SXRS,SHGH,SXRX,SXPN,SXPP,SXUL, SXYK,NAEU,SXRW,SXCD,SXHI,SXRR,SXRQ,NADZ,NAEA,
	8	20	SXDP	AZUE,AZUD,AZBT,AZBU,AZDU,NADE,AZJU,AZKU,NACQ,NACR, AZFU,AZCU,NADF,AZEU,AZLU,AZUC,SXDF,SXDI,NABJ,
	9	17	AZTE	AZQI,AZAC,AZBC,AZXY,AZNS,AZAX,AZAB,AZTD,AZAA,AZQJ, AZUP,AZJL,AZQL,AZTS,AZQK,AZRI,
	10	18	AZUN	NAEQ,AZAS,AZUA,NABU,AZAD,AZFA,AZAH,AZLS,AZFF,AZKY, AZJY,AZYL,AZHU,AZGR,NAEP,AZIP,AZIE,
	11	13	NAAN	NAAP,NAAG,NACX,AZYI,NAEO,NACE,AZIZ,AZFR,NABR,AZON, NACC,NAAO,
	12	11	AZUS	AZUS,AZNA,AZRK,AZUZ,AZZC,AZZA,AZZP,AZUQ,AZCN,AZXL,
	13	17	AZUX	DQJH,DQIY,NACL,DQCW,DQJY,DQNU,DQNH,NADM,NABI,DQGS, DQKH,NACI,DQEA,DQEJ,NACD,DQAC,
	14	14	AZBN	AZAE,AZAI,NAAI,AZAJ,AZZB,NAEX,NAEV,NAFW,AZUW,AZAZ, NADO,NABZ,AZBX,
	15	20	DQHT	DQHP,DQCF,DQHN,DQIT,DQHQ,DQHR,DQAD,DQFT,DQET,DQDT, DQHJ,DQIH,NADP,DQHW,DQHS,DQHY,NABC,NABH,DQBY,
	16	1	DTJ	
	17	16	DTL	DQMJ,DQTR,DQTW,DQBD,DQGD,DQCS,DQRS,DQNA,DQCT,DQHL, DQHI,DQBT,DQRK,DQSU,DQHZ,

298

Table 12-3. Terminal Assignments (Continuation 1)

18	10	DQHU	DQHX, DQGB, DQNB, DQBE, DQLX, DQCA, NABQ, DQLZ, NABF,
19	17	DQEK	DQED, DQEL, DQEI, NADP, DQDY, NADI, NADY, NADT, NADS, NACO, NACP, NAE[illegible], NADO, DQDQ, DQUT, NAEJ,
20	16	AZXJ	AZDA, AZ[illegible], [illegible], AZAF, AZXQ, AZXP, AZXW, AZGW, AZXS, AZXR, AZXI, AZX[illegible], [illegible]CE, DQDC, DQHK,
21	21	DQGY	DQEE, DQDZ, DQKY, NAEG, NAAU, DQGX, DQLH, DQLY, DQER, DQPF, DQEC, DQEW, NABS, DQGS, DQKH, NACI, NAEZ, NAAR, NAAS, DQEZ,
22	12	DQJT	DQBH, NACT, AZUI, NACF, DQRD, DQHC, DQHE, DQHF, DQEY, DQVI, DQSL,
23	18	DQKT	DQCY, DTQ , DQNW, DQLT, DQHA, DQHD, DQHT, DQHH, DQHB, DTC , DQZY, NAEF, NAED, DQBZ, DQCH, NAEE, DQDH,
24	19	AZUF	AZXH, AZYC, NAAW, NAAX, DQEN, DQDR, AZGN, DQEF, DQDW, DQEP, NAAA, AZRZ, AZAR, NADU, NADK, NAER, NACJ, NA[illegible],
25	17	AZPW	NAAL, AZPS, NABE, AZAZ, DQAY, NABF, NACH, [illegible]Y, DQGJ, DQGJ, NADG, NADH, AZPX, NABB, AZPZ, NADQ,
26	17	AZIJ	AZIK, AZJP, AZJA, AZZN, SZGF, SXGR, NAE[illegible], NAEM, SXRA, NADA, AZZJ, AZIL, NAEN, AZGO, AZIN, NAEY,
27	19	AZLA	AZLB, AZTI, AZLC, AZKA, AZLD, NACG, AZK[illegible], AZWR, NAAV, AZWN, AZWP, AZWQ, AZWX, AZLI, NAAF, AZZK, AZWS, NAEC,
28	17	AZIS	AZIW, AZGM, AZIF, AZII, AZLJ, AZKS, AZIX, AZJK, AZLE, AZLF, AZFA, AZLN, AZIR, NABV, AZIQ, NAAB,
29	17	AZPN	AZPP, AZPL, AZPI, AZGL, AZLK, AZLL, AZLP, NABG, AZKW, AZPC, AZYE, AZXZ, AZLQ, AZPJ, AZPK, AZRB,
30	18	AZWL	NADL, AZAM, AZWJ, AZWK, NAAT, AZWE, AZWF, NABY, NACM, AZSP, AZWB, AZWA, AZSZ, AZWD, NADC, AZWC, AZSX,
31	13	AZGA	AZQB, AZQC, NAAQ, NABM, AZGF, AZPE, NAER, AZQE, AZPD, AZQD, AZPA, AZKD,
32	18	AZAG	AZQA, AZAG, AZJQ, NADJ, AZJE, NAAJ, AZMJ, AZGE, AZRI, AZJF, AZJI, AZKJ, AZJD, NABO, AZLR, AZZI, AZZF,
33	15	DTF	DQGI, AZJR, AZJS, AZKK, AZKP, AZKR, AZJW, AZKQ, NABA, AZKN, DQEH, AZKL, NAES, AZKF,
34	11	AZBF	NAET, DQGZ, NAAY, NAAZ, NACB, AZWI, AZWW, NBEH, AZZL, AZJZ,
35	16	NAAM	AZGG, AZUR, NACV, NACZ, SXQR, NABW, SXGK, SXPF, NACU, SXBE, NADV, AZZR, NADB, AZZW, AZZX,

Table 12-4. Network Option Costs in Thousands of Dollars

Network: TLETS
Remarks: Single Region - Austin

Number of Regions: 1

Item	No. Reqd.	Recurring Costs: Annual Cost Each	Recurring Costs: Total Annual Cost	Recurring Costs: Eight Year Cost	One Time Installation Costs: Unit Cost	One Time Installation Costs: Total Purchase Cost	Total: Eight Year Cost by Item
Lines, Modems Service Terminals	-	-	611	4,888	-	37	4,925
Terminals	564	1.260	711	5,700	8.847	5,000	10,700
Regional Switchers	0						
Switcher Floor Space							
Switcher Back up Power	0						
Switcher Personnel	0						
Engineering					-	130	130
Subtotals				10,588		5,167	15,755
			Total Eight Year Cost:				15,800

300

Table 12-5. Network Line Characteristics

Network: TLETS Number of Regions: 1
Remarks: Austin as Regional Center

Line No.	First Node	No. of Terminals	Line Type (Baud)	Line Utilization	Total Mileage (mi)	Mean Response Time (sec)
1	SXLP	10	1200	0.643	73	8.7
2	AZIO	20	2400	0.611	154	4.6
3	SXQQ	19	1200	0.068	374	3.8
4	AZFI	17	1200	0.157	313	4.1
5	SXKA	19	1200	0.145	469	4.1
6	SXQP	20	1200	0.181	356	4.2
7	SXRK	19	1200	0.169	433	4.2
8	SXDP	20	1200	0.213	415	4.4
9	AZTE	17	1200	0.243	0	4.1
10	AZUN	18	1200	0.101	304	4.0
11	NAAN	13	1200	0.037	218	3.6
12	AZUS	11	1200	0.083	143	3.7
13	AZUX	17	1200	0.115	396	3.9
14	AZBN	14	1200	0.064	255	3.7
15	DQHT	20	1200	0.310	297	4.9
16	DTJ	11	4800	0.445	181	2.6
17	DTL	16	1200	0.556	181	2.5
18	OQHU	10	1200	0.095	309	3.7
19	DQEK	17	1200	0.076	441	3.8
20	AZXJ	16	1200	0.145	286	4.0
21	DQGY	19	1200	0.137	451	4.1
22	DQJT	12	1200	0.123	254	3.9
23	DQKT	19	1200	0.319	213	5.0
24	AZUF	19	1200	0.095	449	4.0
25	AZPW	17	1200	0.065	356	3.8
26	AZIJ	19	1200	0.124	698	4.0
27	AZLA	19	1200	0.054	623	3.8
28	AZIS	17	1200	0.083	523	3.8
29	AZPN	17	1200	0.130	550	4.0
30	AZWL	18	1200	0.172	661	4.2
31	AZGA	14	1200	0.083	386	3.8
32	AZAG	18	1200	0.247	706	4.5
33	DTF	15	1200	0.080	446	3.8
34	AZBF	11	1200	0.025	489	3.5
35	NAAM	16	1200	0.051	317	3.7

30?

The least cost configuration of these four possibilities is the Austin-Dallas network shown in Figure 12-2. The Austin region consists of 16 1200 Baud lines and one 2400 Baud line for a total of 17 lines. The Dallas region is comprised of 18 1200 Baud lines and one 2400 Baud line for a total of 19 lines. A single 4800 Baud line connects the two regional computers. Table 12-6 details the terminal assignments by line for the two region case.

12.3.2 Costs

Total eight-year costs for the two region Austin-Dallas network are shown in Table 12-7. There is no purchase cost shown for the Dallas regional switcher or for an uninterruptable power supply since these facilities presently exist. The total cost is $17,000,000 over eight years. Note that the annual line cost of $602,000 is reduced from the $611,000 annual cost in the single region case. Total costs are increased, however, despite the fact that the second switcher need not be purchased due to additional switcher, facility and personnel recurring costs.

Tables 12-8, 12-9, and 12-10 show costing results of considering Lubbock, Midland and Amarillo as locations for a second switcher respectively instead of Dallas. Note that annual line costs are very similar in all two region cases. However, non-existent switching facilities are required in the Western locations.

12.3.3 Line Performance

Table 12-11 presents line performance characteristics for the two region case with switchers in Austin and Dallas. Mean response times vary between 2.2 seconds and 8.7 seconds depending on the particular multidropped line. Of the total of 36 lines for both regions, 34 show mean response times of less than 5 seconds.

12.3.4 Network Availability

If data base and switcher upgrades called for in Section 12.1.2 are implemented, the system availability for the two region case is 0.973. This implies an average daily network outage for terminals connected to the Dallas switcher of 39.0 minutes.

12.4 OPTION 3 - THREE REGION TLETS

12.4.1 Topology

For the STACOM/TEXAS three region case, five possible configurations were studied. Each of the five networks consists of a switcher facility in Austin and Dallas. Candidate locations for a third switcher were San Antonio, Houston, Midland, Amarillo and Lubbock.

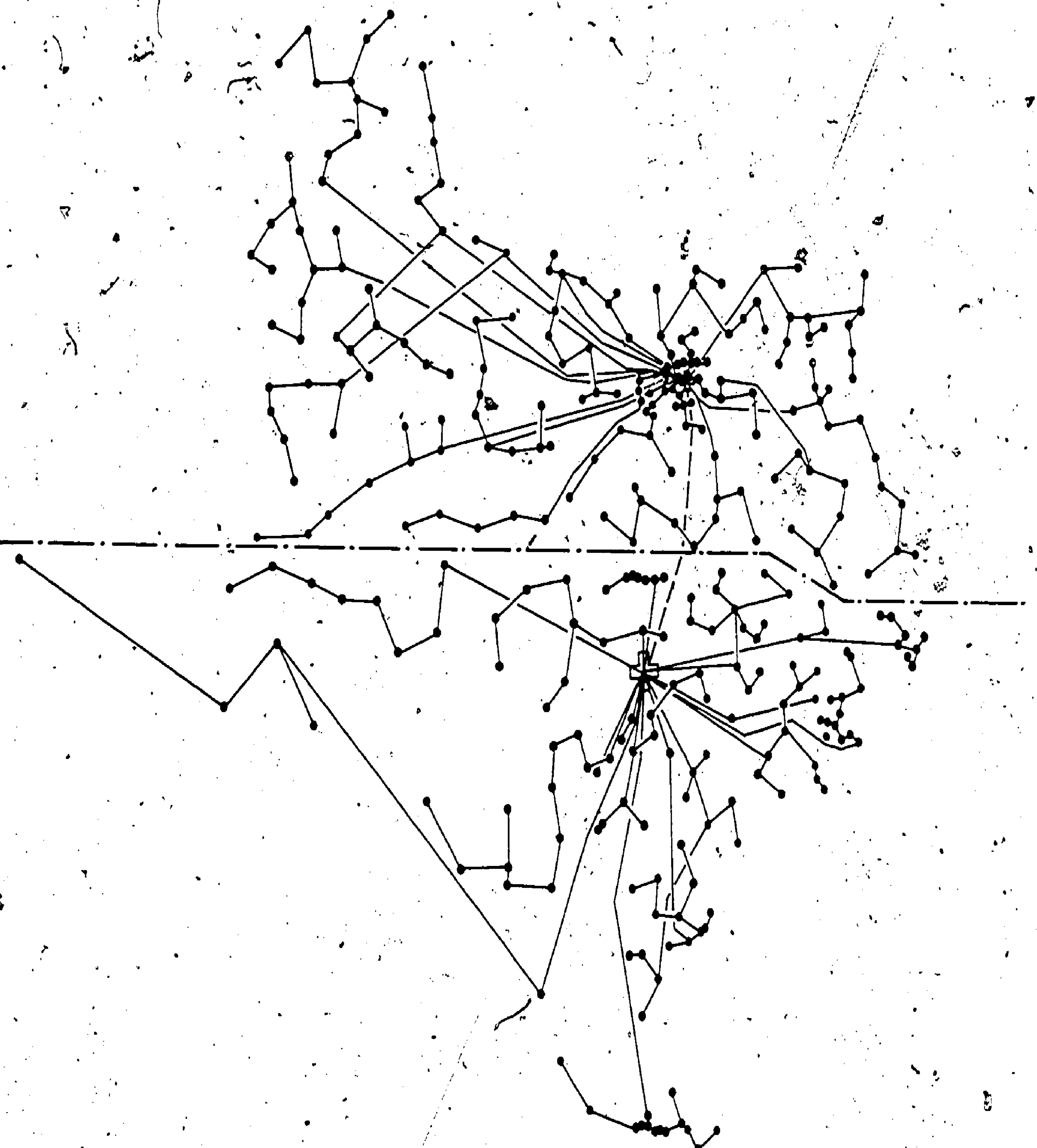


Figure 12-2. Two Region TLETS -- Switches in Austin and Dallas

Table 12-6. Terminal Assignments

WORK OPTION: TLETS/AUSTIN-DALLAS

NUMBER OF REGIONS: 2

AUSTIN REGION	LINE NO.	TOTAL NO.	TERMINALS STARTING	TERMINALS REMAINING
1.				
	1	20	AZID	AZIC,AZAV,AUB ,AUH ,AZAV,AZCS,AZFH,AZFW,AZFL,AZZH, AZHN,AZIB,AZTY,AZFK,AZYN,AZSE,AZUJ,AZUK,AZPB,
	2	16	AZFI	AZFJ,AO+S,AZHC,AZLZ,AZAW,AZFD,AZIA,AZAN,AZYP,AZFB, AZFE,AZAU,AZIU,AZIU,AZYQ,
	3	20	SXKA	NABX,SXGC,SXBK,SXBJ,SXBL,SXRT,SXRS,SXYF,NADX,NADN, SXAD,NADW,SXBI,NAAH,SXWT,SXIT,SXRW,NBAC,SXRZ,
	4	12	SXOP	NACA,NAAO,NAAN,NAAP,MAAG,NACX,NABR,SXSQ,SXKC,NAAD, SXSN,
	5	21	SXRK	SXRL,SXYJ,MACE,SXDA,SXRS,SHGH,SXRY,SXRN,SXRP,SXUL, SXYK,NAEU,SXRW,SXCD,SXHI,SXPR,SXRO,NADZ,NAEA,NAFR,
	6	18	SXDP	SXGV,SXDJ,SXDK,SXBO,SXBP,SXBN,NACS,SXSD,SYBR,NAAK, SXDS,NACN,SXDL,SXDN,SXDF,SXDI,NABJ,
	7	17	AZUE	AZUD,AZBT,AZBU,AZDU,NADE,AZJU,AZKU,NACQ,NACR,AZFU, AZCU,NADF,AZEU,AZLU,AZUC,NADU,
	8	20	AZYI	NAEO,AZBN,AZAE,AZAI,NAAT,AZUF,AZXH,AZYC,AZRZ,AZAJ, AZZB,AZUW,AZAZ,NADO,NACE,AZBX,NABZ,AZIZ,AZFR,
	9	17	AZUN	NAEO,AZAS,AZUA,NABU,AZAD,AZFA,AZAR,AZFF,AZKY,AZJY, AZYL,AZHU,AZGP,NAEP,AZIP,AZIE,
	10	12	AZUS	AZUS,AZUX,NACJ,NACK,AZNA,AZRK,AZUZ,AZZC,AZGG,AZUR, NACV,
	11	10	SXLP	SXFS,S ,SXRJ,SXAY,AZZD,SXQS,SXYA,SXYB,SXQW,
	12	19	SXPR	SXLE,SXBE,NAAF,SXQX,SXRP,NART,NACW,NABK,NABL,SXCC, NAFC,SXQZ,NAEK,SXRA,NADA,SXGR,NAEL,NAEM,
	13	4	AZQN	NACC,SXQQ,NABD,
	14	11	AZAG	AZQA,AZAG,AZZJ,SXGF,AZZN,AZJA,AZJP,AZTL,NAEN,AZGO,
	15	17	AZTE	AZQI,AZAC,AZBC,AZXY,AZNS,AZAX,AZAR,AZTD,AZAA,AZQJ, AZUP,AZJL,AZQL,AZTS,AZQK,AZRI,
	16	15	SXRC	SXRD,AZJQ,NADJ,AZJE,NAAJ,AZMJ,AZGE,AZBI,AZJF,AZJI, AZKJ,AZJD,NABO,AZJH,
	17	14	NAEJ	NAAM,NACZ,SXQR,NABW,SXGK,SXRF,NACU,NADV,AZZR,NADB, AZZW,AZZX,NAEX,

304

Table 12-6. Terminal Assignments (Continuation 1)

DALLAS REGION LINE NO.	TOTAL NO.	STARTING	REMAINING
1	1	DTJ	—
2	18	DTL	DQMJ,DQTR,DQTW,DQBD,DQGD,DQCS,DQRS,DONA,DQCT,DQHL, DQHI,DQBT,DQRK,DQSU,DQHZ,DQDT,DQHJ,
3	9	DQHQ	DQIT,DQHN,DQHP,DQCF,DQHT,DQDC,DQHK,DQCE,
4	19	DQFT	DQET,DQIH,NADP,DQAD,DQHR,NABH,DQBY,DQVI,DQSL,DQRD, DQHC,DQHE,DQHF,DQET,DQHW,DQHS,DQHY,NABC,
5	17	DQHU	DQHX,DQGB,DQNB,DQBE,DQIY,NACL,DQCW,NABI,DQGS,DQKH, NACI,DQLX,DQCA,NABQ,DQLZ,NABF,
6	16	DQJH	NAAW,NAAX,DQEN,DQDR,AZGN,DQEF,NAEH,NADK,DQDW,DQEP, NAAA,DQAC,DQEA,DQEJ,NACD,
7	22	DQJY	DQNU,DQKY,NAEG,NAAU,DQGX,DQLH,DQLY,DQEK,DQPF,DQEC, DQEW,NABS,DQGS,DQKH,NACI,NAEZ,NAAR,NAAS,DQEZ,DQNH, NADM,
8	20	AZXJ	AZDA,AZXN,AZXK,AZAR,NACY,AZAF,AZXQ,AZXP,AZXW,AZGW, AZXS,AZXR,AZXI,AZCN,AZXL,AZZP,AZUQ,AZWZ,AZZA,
9	20	DQGY	DQEE,DQDZ,DQEK,DQED,DQEL,DQDQ,DQUT,NAEJ,DQEI,NADR, DQDX,NADI,NADY,NADT,NADS,NACO,NACP,NAFI,NADD,
10	13	DQJT	NAEE,DQBZ,DQCH,DQBH,NACT,AZUI,NACF,NACH,DQAY,NABP, AZPS,NABE,
11	16	DQKT	DQCY,DTQ ,DQNW,DQLT,DQHA,DQHD,DQHT,DQHH,DQHR,DTC, DQZY,NAEF,NAED,DQDH,DQDD,
12	8	AZPW	NAAL,AZPX,NABB,AZPZ,NADQ,AZZL,AZZF,
13	18	DQGZ	NAAY,NAAZ,AZGL,AZLK,AZLL,AZLR,NABG,AZKW,AZPC,AZYE, AZXZ,AZLQ,NACB,AZWI,AZWW,NAER,AZZL,
14	19	AZLA	AZLB,AZWS,NAEC,AZTI,AZLC,AZKA,AZLD,NACG,AZKK,AZWR, NAAV,AZWN,AZWP,AZZK,AZWQ,AZWX,AZLT,NABE,
15	16	AZPN	AZPP,AZPL,AZPI,AZIS,AZIW,AZGM,AZIF,AZTI,AZIJ,AZIR, AZIN,NAEY,AZPJ,AZPK,AZRB,
16	18	AZWL	NADL,AZAM,AZWJ,AZWK,NAAT,AZWE,AZWF,NABY,NACM,AZSP, AZWB,AZWA,AZSZ,AZWD,NADC,AZSX,AZWC,
17	14	AZGA	AZQB,AZQC,NAAQ,NAAM,AZPE,NAEB,AZQF,NABN,AZQE,AZPD, AZQD,AZPA,AZKD,
18	20	DTF	DQGI,AZJR,AZJS,AZKK,AZKP,AZKR,AZJW,AZKQ,DQGJ,DQGJ, NADG,DQDJ,NADH,NABA,AZKN,DQEH,AZKI,NAES,AZKF,
19	15	AZRF	NAET,AZLJ,AZKS,AZIX,AZJK,AZLE,AZLF,NAFA,AZLN,AZIR, NABV,AZIQ,NAAB,AZJZ,

305

Table 12-7. Network Option Costs in Thousands of Dollars

Network: TLETS Number of Regions: 2
Remarks: Austin - Dallas

Item	No. Reqd.	Recurring Costs: Annual Cost Each	Recurring Costs: Total Annual Cost	Recurring Costs: Eight Year Cost	One Time Installation Costs: Unit Cost	One Time Installation Costs: Total Purchase Cost	Total Eight Year Cost by Item
Lines, Modems Service Terminals	-	-	602	4,816	-	38	4,854
Terminals	564	1,260	711	5,700	8,847	5,000	10,700
Regional Switchers	1	18	18	144	0*	0*	144
Switcher Floor Space	1	4.8	4.8	38	-	-	38
Switcher Back Up Power	1	6.0	6.0	48	0*	0*	48
Switcher Personnel	1 Set	128	128	1,024	-	-	1,024
Engineering						230	230
Subtotals				11,770		5,268	17,038

Total Eight Year Cost: 17,000

*Regional Switch Installation Not Required

306

Table 12-8. Network Option Costs in Thousands of Dollars

Network: TLETS Number of Regions: 2
Remarks: Austin - Lubbock

Item	No. Reqd.	Recurring Costs: Annual Cost Each	Recurring Costs: Total Annual Cost	Recurring Costs: Eight Year Cost	One Time Installation Costs: Unit Cost	One Time Installation Costs: Total Purchase Cost	Total Eight Year Cost by Item
Lines, Modems Service Terminals	-	-	606	4,848	-	38	4,886
Terminals	564	1,260	711	5,700	8,847	5,000	10,700
Regional Switchers	1	18	18	144	350	350	494
Switcher Floor Space	1	4.8	4.8	38	30	30	68
Switcher Back Up Power	1	6.0	6.0	48	20	20	68
Switcher Personnel	1 Set	128	128	1,024	-	-	1,024
Engineering						230	230
Subtotals				11,802		5,668	17,470
				Total Eight Year Cost:			17,500

387

Table 12-9. Network Option Costs in Thousands of Dollars

Network: TLETS

Number of Regions: 2

Remarks: Austin - Midland

Item	No. Reqd.	Recurring Costs: Annual Cost Each	Recurring Costs: Total Annual Cost	Recurring Costs: Eight Year Cost	One Time Installation Costs: Unit Cost	One Time Installation Costs: Total Purchase Cost	Total Eight Year Cost by Item
Lines, Modems Service Terminals	-	-	609	4,872	-	38	4,910
Terminals	564	1.260	711	5,700	8.847	5,000	10,700
Regional Switchers	1	18	18	144	350	350	494
Switcher Floor Space	1	4.8	4.8	38	30	30	68
Switcher Back Up Power	1	6.0	6.0	48	20	20	68
Switcher Personnel	1 Set	128	128	1,024	-	-	1,024
Engineering						230	230
Subtotals				11,826		5,668	17,494

Total Eight Year Cost: 17,500

Table 12-10. Network Option Costs in Thousands of Dollars

Network: TLETS　　　　Number of Regions: 2
Remarks: Austin - Amarillo

Item	No. Reqd.	Recurring Costs: Annual Cost Each	Recurring Costs: Total Annual Cost	Recurring Costs: Eight Year Cost	One Time Installation Costs: Unit Cost	One Time Installation Costs: Total Purchase Cost	Total Eight Year Cost by Item
Lines, Modems Service Terminals	-	-	612	4,896	-	38	4,934
Terminals	564	1,250	711	5,700	8,847	5,000	10,700
Regional Switchers	1	18	18	144	350	350	494
Switcher Floor Space	1	4.8	4.8	38	30	30	68
Switcher Back Up Power	1	6.0	6.0	48	20	20	68
Switcher Personnel	1 Set	128	128	1,024	-	-	1,024
Engineering						230	230
Subtotals				11,850		5,668	17,518
						Total Eight Year Cost:	17,500

309

Table 12-11. Network Line Characteristics

Network: TLETS
Remarks: Austin Region

Number of Regions: 2

Line No.	First Node	No. of Terminals	Line Type (Baud)	Line Utilization	Total Mileage (mi)	Mean Response Time (sec)
1	AZID	20	2400	0.611	154	4.6
2	AZFI	17	1200	0.157	313	4.1
3	SXKA	20	1200	0.177	352	4.2
4	SXQP	12	1200	0.035	240	3.6
5	SXRK	20	1200	0.170	479	4.2
6	SXDP	18	1200	0.112	356	3.9
7	AZUE	17	1200	0.204	338	4.3
8	AZYI	20	1200	0.087	352	3.9
9	AZUN	18	1200	0.101	304	3.9
10	AZUS	12	1200	0.097	224	3.8
11	SXLP	10	1200	0.643	73	8.7
12	SXPR	19	1200	0.077	395	3.9
13	AZQN	4	1200	0.023	46	3.4
14	AZAG	13	1200	0.095	428	3.8
15	AZTE	17	1200	0.243	0	4.1
16	SXRC	15	1200	0.228	841	4.3
17	NAEV	15	1200	0.047	293	3.7

Network: TLETS
Remarks: Dallas Region

Number of Regions: 2

Line No.	First Node	No. of Terminals	Line Type (Baud)	Line Utilization	Total Mileage (mi)	Mean Response Time (sec)
1	DTJ	1	2400	0.472	0	2.2
2	DTL	18	1200	0.325	22	5.0
3	DQHQ	9	1200	0.110	69	3.8
4	DQFT	19	1200	0.242	106	4.5
5	DQHU	17	1200	0.135	231	4.1
6	DQSH	16	1200	0.099	335	3.9
7	DQJY	20	1200	0.105	363	4.0
8	AZXJ	20	1200	0.156	316	4.1
9	DQGY	20	1200	0.129	336	4.1
10	DQJT	13	1200	0.082	172	3.7
11	DQKT	16	1200	0.308	52	4.8
12	AZPW	8	1200	0.020	272	3.5
13	DQGZ	18	1200	0.125	622	4.0
14	AZLA	19	1200	0.054	567	3.8
15	AZPN	16	1200	0.120	424	4.0
16	AZWL	18	1200	0.172	588	4.2
17	AZGA	14	1200	0.083	368	3.8
18	DTF	20	1200	0.116	378	4.0
19	AZBF	15	1200	0.044	517	3.7

The least cost configuration of these five is the network shown in Figure 12-3 employing Austin, Dallas and San Antonio as switcher locations, (see Paragraph 12.4.2). The Austin region consists of ten 1200 Baud lines and two 2400 Baud lines.

The Dallas region services 19 lines, all of which are 1200 Baud lines with the exception of one 4800 Baud line. The San Antonio switcher has six 1200 Baud lines and one 2400 Baud line. A single 4800 Baud line connects the Austin switch to Dallas and a single 4800 Baud line also provides communication from Austin to San Antonio. Table 12-12 provides line topology details for this three region case.

12.4.2 Cost

Tables 12-13 through 12-17 show eight-year cost breakdowns for the five three region cases considered. The Austin-Dallas-San Antonio case exhibits the highest annual line cost of any of the five alternatives considered ($639,000). The overall eight-year cost, however, is less by some $200,000 only because required switching facilities are already in place.

The remaining four cases indicate virtually identical costs when totals are rounded off, although the Austin-Dallas-Houston configuration exhibits the lowest annual line cost of all alternatives, ($597,000).

As in the two-region case, the location of switchers in the Western part of the state appear to be least favorable by slight margins only.

12.4.3 Line Performance

Line performance characteristics for the three region Austin-Dallas-San Antonio configuration are shown in Table 12-18. Mean response times vary from 2.2 seconds to a worst case of 5.0 seconds. Of the total of 38 lines in the network, 22 have mean response times of less than or equal to 4.0 seconds.

12.4.4 Network Availability

If the data base and switcher upgrades called for in Section 12.1.2 are implemented, the three region network will have an availability of 0.973, which implies an average daily system outage for any terminal connected to the Dallas or San Antonio switchers of 39.0 minutes.

311

Figure 12-3. Three Region TLETS with Switchers in Austin, Dallas and San Antonio.(1985)

Table 12-12. Terminal Assignments

NETWORK OPTION: TLFTS/A-D-SA

NUMBER OF REGIONS: 3

REGION	LINE NO.	TOTAL NO.	TERMINALS STARTING	TERMINALS REMAINING
1	1	20	AZID	AZIC,AZAV,AUB ,AUH ,AZAV,AZCS,AZFH,AZFW,AZFL,AZZH, AZHN,AZIB,AZTY,AZFK,AZYN,AZSE,AZUJ,AZUK,AZPB,
	2	17	AZFI	AZFJ,A0+S,AZFZ,AZHC,AZLZ,AZAW,AZFD,AZIA,AZAN,AZYP, AZFB,AZFE,AZAU,AZIU,AZIU,AZYG,
	3	17	AZUE	AZUD,AZBT,AZBU,AZDU,NADE,AZJU,AZKU,NACQ,NACR,AZFU, AZCU,NADF,AZEU,AZLU,AZUC,NADU,
	4	19	AZYI	NAEO,AZBN,AZAE,AZAI,NAAI,AZUF,AZXH,AZYC,AZRZ,AZAJ, AZZB,AZUW,AZAZ,NADO,AZIZ,AZFR,AZBX,NABZ,
	5	18	AZUN	NAEQ,AZAS,AZUA,NABU,AZAD,AZFA,AZAH,AZLS,AZFF,AZKY, AZJY,AZYL,AZHU,AZGP,NAEP,AZIP,AZIE,
	6	6	NAAN	NAAP,NAAG,NACX,NABR,NAAO,
	7	10	AZUS	AZUS,AZUX,AZNA,AZRK,AZUZ,AZZC,AZGG,AZUR,NACV,
	8	13	AZJQ	NADJ,AZJE,NAAJ,AZMJ,AZGE,AZBI,AZJF,AZJI,AZKJ,AZJD, NABO,AZJB,
	9	13	AZAG	AZGA,AZAG,AZZJ,SXGF,AZZN,AZJA,AZJP,AZIL,NAEN,AZGG, AZJC,AZJJ,
	10	17	AZTE	AZQI,AZAC,AZBC,AZXY,AZNS,AZAX,AZAB,AZTD,AZAA,AZQJ, AZUP,AZJL,AZQL,AZTS,AZQK,AZRI,
	11	15	NAEV	NAEW,NAAM,NACZ,SXQR,NABW,SXGK,SXRF,NACU,NADV,AZZR, NADB,AZZW,AZZX,NAEX,
2	1	17	DTJ	DTL ,DQMJ,DQTR,DQTW,DQBD,DQGD,DQCS,DQRS,DQNA,DQCT, DQHL,DQHI,DQBT,DQRK,DQSU,DQHZ,
	2	3	DTL	DQDT,DQHJ,
	3	9	DQHQ	DQIT,DQHN,DQHP,DQCF,DQHT,DQDC,DQHK,DQCE,
	4	19	DQFT	DQET,DQIH,NADP,DQAD,DQHR,NABH,DQBY,DQVI,DQSL,DQRD, DQHC,DQHE,DQHF,DQEY,DQHW,DQHS,DQHY,NABC,
	5	17	DQHU	DQHX,DQGB,DQNB,DQBE,DQIY,NACL,DQCW,NABI,DQGS,DQKH, NACI,DQLX,DQCA,NABQ,DQLZ,NABF,
	6	16	DQJH	NAAW,NAAX,DQEN,DQDR,AZGN,DQEF,NAEH,NADK,DQDW,DQEP, NAAA,DQAC,DQEA,DQEJ,NACD,

Table 12-12. Terminal Assignments (Continuation 2)

	7	21	DQJY	DQNU, DQKY, NAEG, NAAU, DQGX, DQLH, DQLY, DQEK, DQEC, DQEW; NABS, DQGS, DQKH, NACI, NAEZ, NAAR, NAAS, DQEZ, DQNH, NADM,
	8	20	AZXJ	AZDA, AZXN, AZXK, AZAR, NACY, AZAF, AZXQ, AZXP, AZXW, AZGW, AZXS, AZXR, AZXI, AZCN, AZXL, AZZP, AZUQ, AZWZ, AZZA,
	9	20	DQGY	DQEE, DQDZ, DQEK, DQED, DQEL, DQDQ, DQUT, NAEJ, DQEI, NADR, DQDX, NADI, NADY, NADT, NADS, NACO, NACP, NAEI, NADD,
	10	13	DQJT	NAEE, DQBZ, DQCH, DQRH, NACT, AZUI, NACF, NACH, DQAY, NABP; AZPS, NABE,
	11	16	DQKT	DQCY, DTQ , DQNW, DQLT, DQHA, DQHD, DQHT, DQHH, DQHB, DTC ; DQZY, NAEF, NAED, DQDH, DQDD,
	12	8	AZPW	NAAL, AZPX, NABB, AZPZ, NADQ, AZZI, AZZF,
	13	18	DQGZ	NAAY, NAAZ, AZGL, AZLK, AZLL, AZLR, NABG, AZKW, AZPC, AZYE; AZXZ, AZLQ, NACB, AZWI, AZWW, NAER, AZZL,
	14	19	AZLA	AZLB, AZWS, NAEC, AZTI, AZLC, AZKA, AZLD, NACG, AZKK, AZWR; NAAV, AZWN, AZWP, AZZK, AZWQ, AZWX, AZLI, NAAE,
	15	16	AZPN	AZPP, AZPL, AZPI, AZIS, AZIW, AZGM, AZIF, AZII, AZIJ, AZIK; AZIN, NAEY, AZPJ, AZPK, AZRR,
	16	18	AZWL	NADL, AZAM, AZWJ, AZWK, NAAT, AZWE, AZWF, NABY, NACM, AZSP, AZWB, AZWA, AZSZ, AZWD, NADC, AZSX, AZWC,
	17	14	AZGA	AZQB, AZQC, NAAQ, NABM, AZPE, NAEB, AZQF, NABN, AZQE, AZPD; AZQD, AZPA, AZKD,
	18	20	DTF	DQGI, AZJR, AZJS, AZKK, AZKP, AZKR, AZJW, AZKQ, DQGJ, DQGJ; NADG, DQDY, NADH, NABA, AZKN, DQEH, AZKL, NAES, AZKF,
	19	15	AZBF	NAET, AZLJ, AZKS, AZIX, AZJK, AZLE, AZLF, NAFA, AZLN, AZIR; NABV, AZIQ, NAAB, AZJZ,
3				
	1	10	SXLP	SXFS, S , SXRJ, SXAY, AZZD, SXQS, SXYA, SXYB, SXQW,
	2	18	SXLE	SXBE, NAAF, SXQX, SXRB, NABT, NACW, NABK, NABL, SXCC, NAFC; SXQZ, NAEK, SXRA, NADA, SXGR, NAEL, NAEM,
	3	20	SXQP	NACA, SXKA, NABX, SXDP, SXGV, SXDJ, SXDK, SXDS, NACN, SXDL; SXDN, SXDI, NABJ, SXDF, SXQQ, NABD, SXPR, AZQN, NACC,
	4	20	SXRK	SXRL, SXYJ, NACE, SXDA, SXRS, SHGH, SXRX, SXRN, SXRP, SXUL; SXYK, NAEU, SXRW, SXCD, SXHI, SXRR, SXRQ, NADZ, NAEA,
	5	10	SXBQ	SXBP, SXRC, SXRD, NAFB, SXBN, NACS, SXSD, SXBR, NAAK,
	6	18	SXGC	SXBK, SXBJ, SXBL, SXRT, SXBS, SXYF, NADX, NADW, SXBI, NAAH; SXWT, NADN, SXAD, SXIT, SXBW, NAAC, SXRZ,
	7	4	SXSQ	NAAD, SXSN, SXKC,

34567890123456789012345678901234567890123456789012345678901234567890123456789012345

Table 12-13. Network Option Costs in Thousands of Dollars

Network: TLETS
Remarks: Austin - Dallas - San Antonio

Number of Regions: 3

Item	No. Reqd.	Recurring Costs: Annual Cost Each	Recurring Costs: Total Annual Cost	Recurring Costs: Eight Year Cost	One Time Installation Costs: Unit Cost	One Time Installation Costs: Total Purchase Cost	Total Eight Year Cost by Item
Lines, Modems Service Terminals	-	-	639	5,112	-	40	5,152
Terminals	564	1,260	711	5,760	8,847	5,000	10,700
Regional Switchers	2	18	36	288	0*	0*	288
Switcher Floor Space	2	4.8	9.6	77	0*	0*	77
Switcher Back Up Power	2	6	12	96	0*	0*	96
Switcher Personnel	2	128	256	2,048	-	-	2,048
Engineering						130	130
Subtotals				13,321		5,170	18,491
						Total Eight Year Cost:	18,500

*Switches exist in Dallas and San Antonio

Table 12-14. Network Option Costs in Thousands of Dollars

Network: TLETS
Remarks: Austin - Dallas - Houston

Number of Regions: 3

Item	No. Reqd.	Recurring Costs: Annual Cost Each	Recurring Costs: Total Annual Cost	Recurring Costs: Eight Year Cost	One Time Installation Costs: Unit Cost	One Time Installation Costs: Total Purchase Cost	Total Eight Year Cost by Item
Lines, Modems Service Terminals	-	-	597	4,776	-	38	4,814
Terminals	564	1.260	711	5,700	8.847	5,000	10,700
Regional Switchers	2	18	36	288	350	350*	638
Switcher Floor Space	2	4.8	9.6	77	30	30*	107
Switcher Back Up Power	2	6.0	12.0	96	20	20	116
Switcher Personnel	2 Sets	128	256	2,048	-	-	2,048
Engineering						230	230
Subtotals				12,985		5,668	18,653

Total Eight Year Cost: 18,700

*New facility required in Houston only

316

Table 12-15. Network Option Costs in Thousands of Dollars

Network: TLETS
Remarks: Austin - Dallas - Midland

Number of Regions: 3

Item	No. Reqd.	Recurring Costs: Annual Cost Each	Recurring Costs: Total Annual Cost	Recurring Costs: Eight Year Cost	One Time Installation Costs: Unit Cost	One Time Installation Costs: Total Purchase Cost	Total Eight Year Cost by Item
Lines, Modems Service Terminals	-	-	604	4,832	-	38	4,870
Terminals	564	1,260	711	5,700	8,847	5,000	10,700
Regional Switchers	2	18	36	288	350	350	638
Switcher Floor Space	2	4.8	9.6	77	30	30*	107
Switcher Back Up Power	2	6.0	12.0	96	20	20	116
Switcher Personnel	2	128	256	2,048	-	-	2,048
Engineering						230	230
Subtotals				13,041		5,668	18,709
					Total Eight Year Cost:		18,700

*New facility required in Midland only

317

Table 12-16. Network Option Costs in Thousands of Dollars

Network: TLETS

Remarks: Austin - Dallas - Amarillo

Number of Regions: 3

Item	No. Reqd.	Recurring Costs: Annual Cost Each	Recurring Costs: Total Annual Cost	Recurring Costs: Eight Year Cost	One Time Installation Costs: Unit Cost	One Time Installation Costs: Total Purchase Cost	Total Eight Year Cost by Item
Lines, Modems Service Terminals	-	-	607	4,856	-	38	4,894
Terminals	564	1,260	711	5,700	8,847	5,000	10,700
Regional Switchers	2	18	36	288	350	350	638
Switcher Floor Space	2	4.8	9.6	77	30	30*	107
Switcher Back Up Power	2	6.0	12.0	96	20	20	116
Switcher Personnel	2	128	256	2,048	-	-	2,048
Engineering						230	230
Subtotals				13,065		5,668	18,733
						Total Eight Year Cost:	18,700

*New facility required in Amarillo only

318

Table 12-17. Network Option Costs in Thousands of Dollars

Network: TLETS Number of Regions: 3
Remarks: Austin - Dallas - Lubbock

Item	No. Reqd.	Recurring Costs: Annual Cost Each	Recurring Costs: Total Annual Cost	Recurring Costs: Eight Year Cost	One Time Installation Costs: Unit Cost	One Time Installation Costs: Total Purchase Cost	Total Eight Year Cost by Item
Lines, Modems Service Terminals	-	-	602	4,816		38	4,854
Terminals	564	1,260	711	5,700	8,847	5,000	10,700
Regional Switchers	2	18	36	288	350	350	638
Switcher Floor Space	2	4.8	9.6	77	30	30*	107
Switcher Back Up Power	2	6.0	12.0	96	20	20	116
Switching Personnel	2	128	256	2,048	-	-	2,048
Engineering						230	230
Subtotals				13,025		5,668	18,693
					Total Eight Year Cost:		18,700

*New facility required in Lubbock only

319

Table 12-18: Network Line Characteristics

Network: TLETS Number of Regions: 3
Remarks: Austin Region

Line No.	First Node	No. of Terminals	Line Type (Baud)	Line Utilization	Total Mileage (mi)	Mean Response Time (sec)
1	AZID	20	2400	0.611	154	4.6
2	AZFI	17	1200	0.157	313	4.1
3	AZUF	20	1200	0.220	373	4.4
4	AZYI	15	1200	0.067	269	3.7
5	AZUN	18	1200	0.101	304	3.9
6	NAAN	6	1200	0.012	111	3.4
7	AZBN	18	1200	0.141	372	4.1
8	AZID	20	2400	0.611	154	4.6
9	AZFI	17	1200	0.157	313	4.1
10	AZBT	20	1200	0.186	437	4.3
11	AZUN	18	1200	0.101	304	4.0
12	NAAG	9	1200	0.021	165	3.5

Network: TLETS Number of Regions: 3
Remarks: Dallas Region

Line No.	First Node	No. of Terminals	Line Type (Baud)	Line Utilization	Total Mileage (mi)	Mean Response Time (sec)
1	DTJ	1	4800	0.472	0	2.2
2	DTL	18	1200	0.325	22	5.0
3	DQHQ	9	1200	0.110	69	3.8
4	DQFT	19	1200	0.242	106	4.5
5	DQHU	17	1200	0.135	231	4.1
6	DQJH	16	1200	0.099	335	3.9
7	DQJY	20	1200	0.105	363	4.0
8	AZXJ	20	1200	0.156	316	4.2
9	DQGY	20	1200	0.129	336	4.1
10	DQJT	13	1200	0.082	172	3.8
11	DQKT	16	1200	0.308	52	4.8
12	AZPW	8	1200	0.020	272	3.5
13	DQGZ	18	1200	0.125	622	4.0
14	AZLA	19	1200	0.054	567	3.8
15	AZPN	16	1200	0.120	424	4.0
16	AZWL	18	1200	0.172	588	4.2
17	AZGA	14	1200	0.083	368	3.8
18	DTF	20	1200	0.116	378	4.0
19	AZBF	15	1200	0.044	517	3.7

Table 12-18. Network Line Characteristics (Continuation 1)

Network: TLETS — Number of Regions: 3
Remarks: San Antonio Region

Line No.	First Node	No. of Terminals	Line Type (Baud)	Line Utilization	Total Mileage (mi)	Mean Response Time (sec)
1	SXLP	10	2400	0.324	0	2.7
2	SXLE	12	1200	0.037	220	3.5
3	SXQP	19	1200	0.095	319	3.8
4	SXRK	19	1200	0.169	376	4.1
5	SXBQ	10	1200	0.090	341	3.6
6	SXGC	18	1200	0.172	310	4.1
7	SXSQ	4	1200	0.015	82	3.3

12.5 OPTION 4 - SEPARATE TLETS AND NEW DATA NETWORKS

12.5.1 Topology

Growth of new data types in Texas is such that communication facilities for these data types should be implemented in two phases. An initial network to handle traffic requirements through 1980 is shown in Figure 12-4. A complete network sufficient to handle predicted new traffic volumes from 1981 through 1985 is shown in Figure 12-5. Both networks are basically starred networks to provide desired response times at terminals.

Table 12-19 lists cities included in the network which functions through 1980 and Table 12-20 shows terminals to be added to make up the final new data network which functions from 1981 through 1985. The first network employs 14 terminals. In the second network 18 locations are added for a total of 32.

321

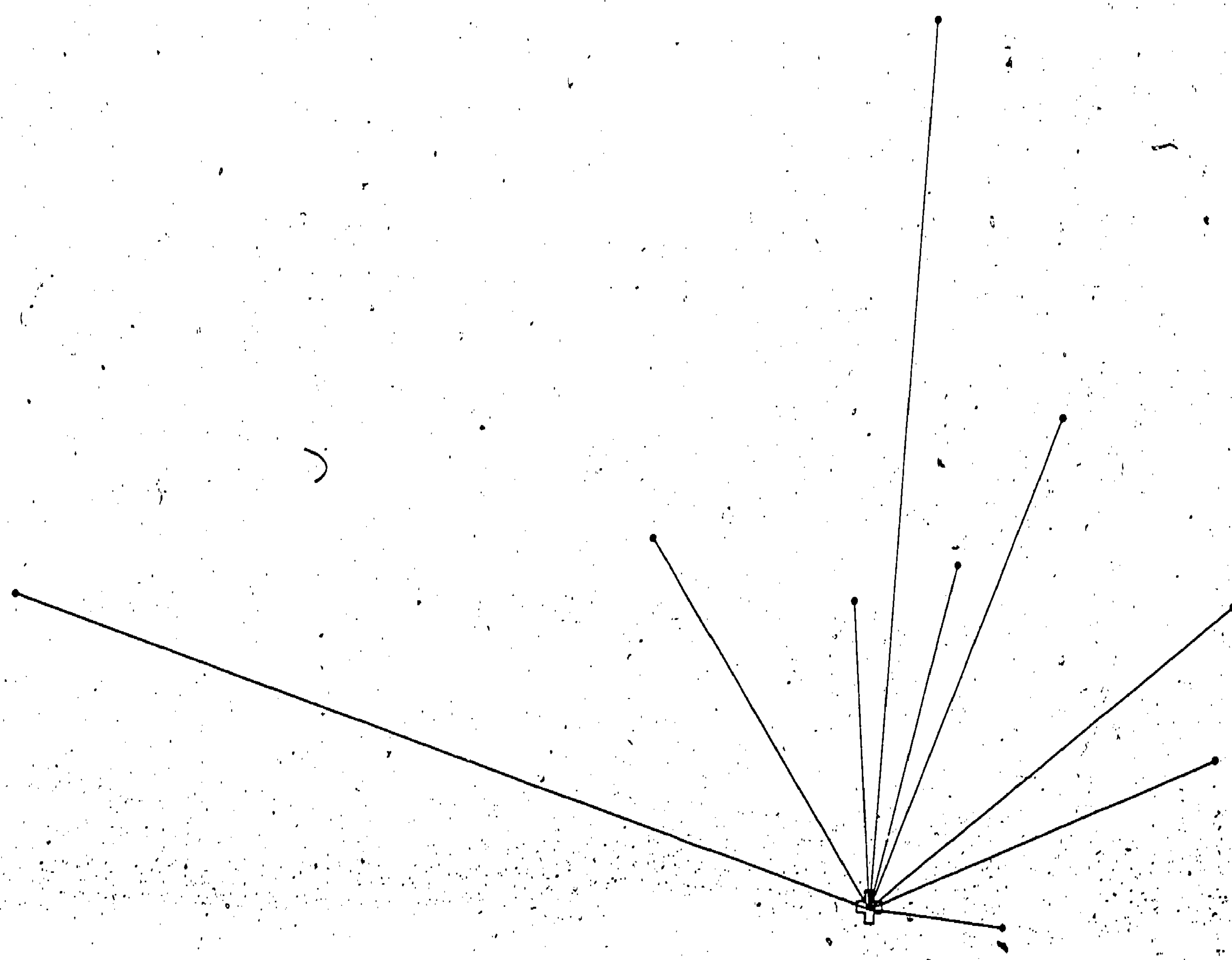


Figure 12-4. Texas Separate New Data Network Through 1980

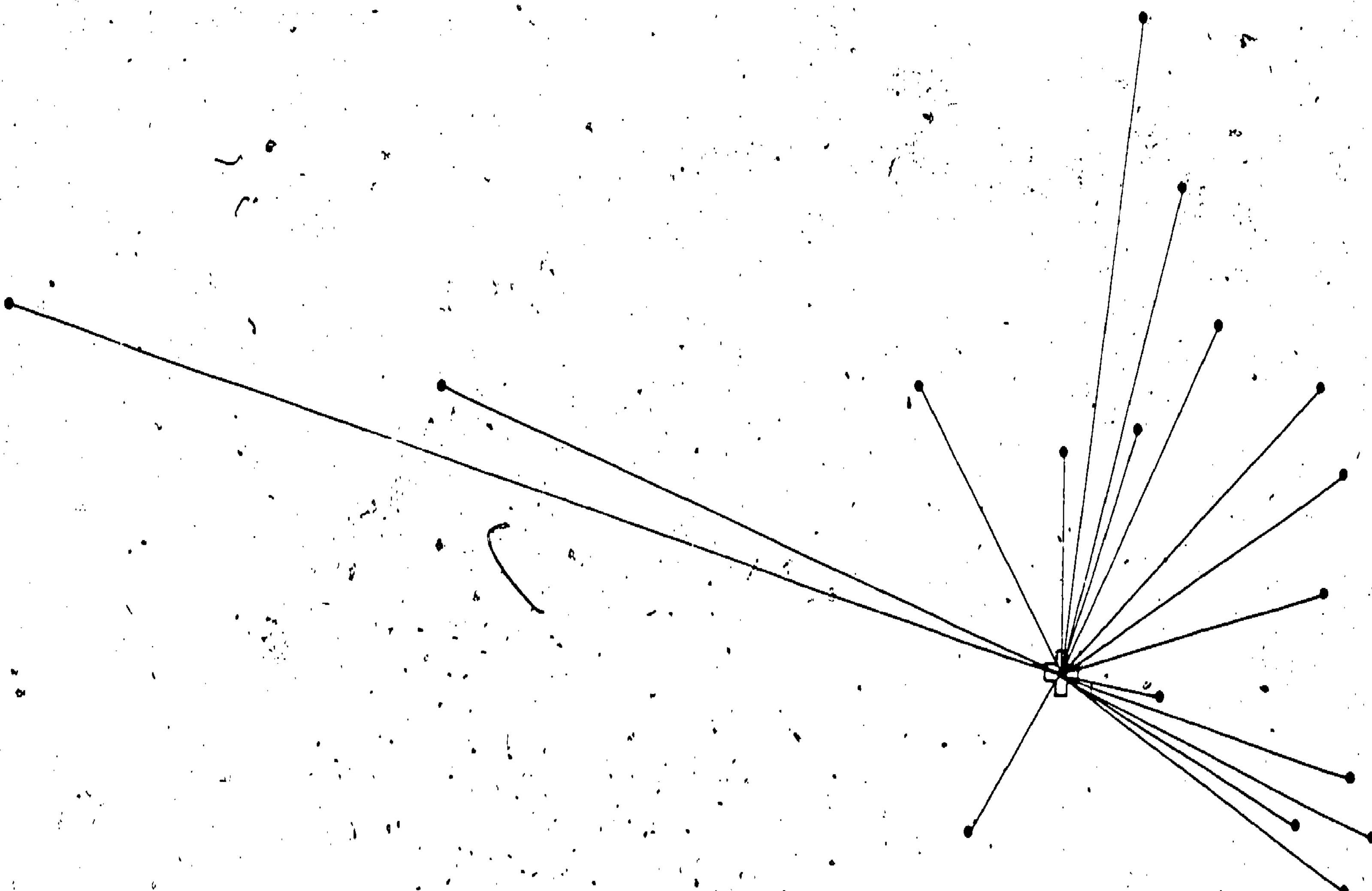


Figure 12-5. Texas Separate New Data Network 1981 Through 1985

Table 12-19. Separate New Data Terminals Through 1980

Code Name	Terminal Location
ICRA	ICR Data Conversion, Austin
TDCA*	TDC H.Q., Huntsville
BPPA*	BPP H.Q., Austin
TYCA	TYC H.Q., Austin
TYCB	Gatesville TYC, Coryel
TYCC	Gainesville TYC, Cooke
TYCD	Giddings TYC, Lee
TYCE	Brownwood TYC, Brown
TYCF	Corsicana TYC, Navarro
TYCG	Pyote TYC, Ward
TYCH	Waco TYC, McLennan
TYCI	Crockett TYC, Houston

*2 terminals, 1 each for CCH and OBSCIS

Table 12-20. Separate New Data Terminals to be Added to Those of Table 12.19 to Make up 1981 Through 1985 Network

Code Name	Terminal Location
CTAD	El Paso Courts
TDCC	Eastham CCH, Fodice
TDCG	Ramsey I CCH, Angleton
TDCI	Ramsey II CCH, Angleton
TDCK	Jester CCH, Stafford
TDCO	Goree CCH, Huntsville
CTAA	Dallas-Ft. Worth Courts
CTAE	Austin Courts
TDCD	Ellis CCH, Riverside
TDCH	Clemens CCH, Brazoria
TDCL	Retrieve CCH, Angleton
TDCP	Mt View CCH, Coryell
CTAB	Houston Courts
TDCE	Ferguson CCH, Weldon
TDCM	Central CCH, Stafford
CTAC	San Antonio Courts
TDCB	Coffield CCH, Palestine
TDCF	Wynne CCH, Huntsville
TDCJ	Darrington CCH, Alvin
TDCN	Huntsville Diag. CCH

12.5.2 Cost

Total eight-year costs for the separate new data network amount to $1,350,000 as shown in Table 12-21. Costs for lines, modems, service terminals and network terminals are broken down for required network phasing. It is assumed that the first network is built in 1978 and the second in 1981. As in previous costing, new terminals for the network are purchased.

It is assumed that new data type files, with the exception of CCH files, will be implemented at a new single computer facility in Austin. That is, functions of the TDC, BPP, TYC, OBSCIS and SJIS will be integrated on a single computer. Required mean service times for this computer are indicated in Table 12-22.

The costing of this computer is not included in the cost comparisons for Options 4 and 5. This does not invalidate the cost comparisons carried out here, since the comparative issue is network integration with TLETS lines versus separate new data network construction. In either case, a separate computer facility from the TCIC/LIDR and MVD facilities is called for.

12.5.3 Line Performance

Line performance characteristics for the 1981 through 1985 new data network are shown in Table 12-22. Mean response times vary between 11.9 seconds and 17.7 seconds for the lines. These response times are in keeping with functional requirements for these data types.

12.5.4 Network Availability

The network availability for the separate new data network is calculated at 0.974 which implies an average outage per day of 37.0 minutes. This assumes similar performance as in the single region TLETS Network.

12.6 OPTION 5 - AN INTEGRATED TLETS AND NEW DATA NETWORK

12.6.1 Topology

Integration of new data type terminals into the TLETS network involves a two-step implementation procedure as new data terminals are added to the network in the same manner that the separate new data network implementation is carried out. The network consists of a single region TLETS network with new data terminals added at appropriate points. Table 12-23 lists terminals assigned to the 43 lines called for in the integrated network of 1981-85. Six of the new data terminals remain connected in a star configuration and the remainder of the new data terminals are integrated into multidropped lines with law enforcement agencies.

Table 12-21. Network Option Costs in Thousands of Dollars

Network: New Data Number of Regions: 1
Remarks: Separate New Data Network

Item	No. Reqd.	Recurring Costs: Annual Cost Each	Total Annual Cost: To 1980	Total Annual Cost: 1981-1985	Eight Year Cost	One Time Installation Costs: Unit Cost	Total Purchase Cost: 1978	Total Purchase Cost: 1981	Eight Year Cost by Item
Lines, Modems Service Terminals	-	-	51	121	758	-	1.8	2.6	762.4
Terminals	14/32*	1,260	18	40	254	8.847	124	159*	537
Regional Switchers									
Switcher Floor Space									
Switcher Back Up Power									
Switcher Personnel									
Engineering							40	10	50
Subtotals					1,012		165.8	171.6	1,349.4

Total Eight Year Cost: 1,350

*18 additional units

Table 12-22. Network Line Characteristics

Network: New Data Type Number of Regions: 1
Remarks: Austin as Regional Center

Line No.	First Node	No. of Terminals	Line Type (Baud)	Line Utilization	Total Mileage (mi)	Mean Response Time (sec)
1	ICRA	1	2400	0.512	0	14.6
2	CTAA	1	4800	0.611	181	11.9
3	CTAB	1	4800	0.544	147	11.3
4	CTAC	1	2400	0.473	73	13.7
5	CTAD	1	1200	0.364	530	17.7
6	CTAE	1	1200	0.362	0	17.7
7	TDCA	1	2400	0.367	134	13.2
8	TDCB	1	1200	0.180	162	16.0
9	TDCC	1	1200	0.180	154	16.0
10	TDCD	1	1200	0.163	134	15.8
11	TDCE	1	1200	0.150	154	15.6
12	TDCF	1	1200	0.140	134	15.5
13	TDCG	1	1200	0.128	159	15.4
14	TDCH	1	1200	0.088	159	15.1
15	TDCI	1	1200	0.077	159	15.0
16	TDCJ	1	1200	0.066	161	15.0
17	TDCK	1	1200	0.066	126	15.0
18	TDCL	1	1200	0.060	159	14.9
19	TDCM	1	1200	0.060	126	14.9
20	TDCN	1	1200	0.052	134	14.8
21	TDCO	1	1200	0.038	134	14.7
22	TDCP	1	1200	0.027	80	14.6
23	BPPA	1	2400	0.382	0	13.2
24	TYCA	1	1200	0.082	0	15.0
25	TYCB	1	1200	0.059	80	14.9
26	TYCC	1	1200	0.027	233	14.6
27	TYCD	1	1200	0.027	49	14.6
28	TYCE	1	1200	0.082	124	15.0
29	TYCF	1	1200	0.014	145	14.5
30	TYCG	1	1200	0.014	320	14.5
31	TYCH	1	1200	0.014	95	14.5
32	TYCI	1	1200	0.014	154	14.5

12.6.2 Costs

Total eight-year costs for the integrated TLETS New Data Type Network are $16,300,000 as shown in Table 12-24. The phasing for line reconfiguration and addition of 18 new terminals in 1981 is indicated.

12.6.3 Line Performance

Line performance for the integrated TLETS New Data Type Network is tabulated in Table 12-25. Response times vary from 2.5 seconds to 8.2 seconds. Line configurations are such that prioritization of law enforcement message types is not required.

12.6.4 Network Availability

Assuming data base upgrades called for in Section 12.1.2 are implemented, the availability of data bases to any terminal on the network is 0.974. This availability implies an average network daily outage at any terminal on the network of 37.0 minutes.

12.7 COMPILATION OF COST AND PERFORMANCE DATA - OPTIONS 1 THROUGH 5

Table 12-26 compiles cost and performance data presented in this section for each of the five STACOM/TEXAS Network options.

The next Section discusses these findings and also presents results of additional network studies carried out in Texas.

Table 12-23. Terminal Assignments

NETWORK OPTION: TLETS WITH NEW DATA TYPE

NUMBER OF REGIONS: 1

REGION	LINE NO.	TOTAL NO.	TERMINALS STARTING	TERMINALS REMAINING
1				
	1	10	SXLP	SXFS,S ,SXRJ,SXAY,AZZD,SXQS,SXYA,SXYB,SXQW,
	2	19	SXKA	NABX,SXGV,SXDJ,SXDK,SXBQ,SXBP,SXRC,SXRD,NAFB,SXBN; NACS,SXSD,SXBR,NAAK,SXDS,NACN,SXDL,SXDN,
	3	20	SXQP	NACA,SXGC,SXBK,SXBJ,SXBL,SXRT,SXBS,SXYF,NADX,NADN; SXAD,NADW,SXBI,NAAH,SXWT,SXIT,SXBW,NAAC,SYRZ,
	4	20	SXRK	SXRL,SXYJ,NACE,SXDA,SXRS,SHGH,SXRX,SXRN,SXRP,SXUL; SXYK,NAEU,SXRW,SXCD,SXHI,SXRR,SXRQ,NADZ,NAEA,
	5	19	SXDP	AZUN,NAEQ,TDCL,TDCI,TDCH,TDCG,AZAD,AZFA,AZAH,AZLS, AZFF,AZGP,NAEP,AZIP,AZIF,SXDF,SXDI,NABJ,
	6	16	AZUE	AZUD,AZBT,AZBU,AZDU,NADE,AZJU,AZKU,NACQ,NACR,AZFU, AZCU,NADF,AZEU,AZLU,AZUL,
	7	17	AZTE	AZQI,AZAC,AZBC,AZXY,AZNS,AZAX,AZAB,AZTD,AZAA,AZQJ; AZUP,AZJL,AZQL,AZTS,AZQK,AZPI,
	8	18	AZYI	NAEO,TDCM,AZAS,AZUA,NABU,AZKY,AZJY,AZYL,AZHU,NACE, AZIZ,AZID,NABR,TYCD,NAAG,NACX,AZFR,
	9	5	NAAN	NAAP,AZQN,NACC,NAAQ,
	10	1	ICRA	
	11	1	CTAB	
	12	1	CTAC	
	13	20	CTAE	SXCQ,NABD,SXPR,SXSQ,SXKC,NAAD,SXSN,SXLE,NAAF,SXQX, SXRB,NABT,NACW,NABK,NABL,SXCC,NAFC,SXQZ,NAEK,
	14	20	TDCK	AZIC,AZAV,AUB ,AUH ,AZAV,AZCS,AZFH,AZFW,AZFL,AZZH, AZHN,AZIB,AZTY,AZFK,AZYN,AZSE,AZUJ,AZUK,AZPB,
	15	1	BPPA	
	16	15	TYCA	AZFI,AZFJ,AO+S,AZHC,AZLZ,AZAW,AZFD,AZIA,TDCJ,AZAN, AZYP,AZFB,AZFE,AZAU,AZIU,AZIU,AZYQ,
	17	13	AZUS	AZUS,AZNA,AZRK,AZUZ,AZZC,AZZA,TYCR,AZCN,AZXL,TDCP, AZZP,AZUQ,
	18	13	AZUX	TYCH,AZAF,AZXQ,NACY,AZXN,AZXK,AZXP,AZXW,AZGW,AZXS, AZXR,AZXI,

Table 12-23. Terminal Assignments (Continuation 1)

19	14	AZBN	AZAE,AZAI,NAAI,AZAJ,AZZR,NAEX,NAEV,NAEW,AZUW,AZAZ, NADO,NABZ,AZBX,
20	20	DQHT	DQHP,DQCF,DQHN,DQIT,DQHQ,DQHR,DQAD,DQFT,DQFT,DQDT, DQHJ,DQIH,NADP,DQHW,DQHS,DQHY,NABC,NABH,DQBY,
21	1	DTJ	
22	16	DTL	DQMJ,DQTR,DQTW,DQBD,DQGD,DQCS,DQRS,DQNA,DQCT,DQHL, DQHI,DQBT,DQRK,DQSU,DQHZ,
23	16	DQJH	DQIY,NACL,DQCW,DQJY,DQNU,DQNH,NADM,NABI,DQGS,DQKH, NACI,DQEA,DQEJ,NACD,DQAC,
24	21	DQGY	DQEE,DQDZ,DQKY,NAEG,NAAU,DQGX,DQLH,DQLY,DQER,DQPF, DQEC,DQEW,NABS,DQGS,DQKH,NACI,NAEZ,NAAK,NAAS,DQEZ,
25	12	DQJT	DQBH,NACT,AZUI,NACF,DQRD,DQHC,DQHE,DQHF,DQEY,DQVI, DQSL,
26	19	DQKT	DQCY,DTQ ,DQNW,DQLT,DQHA,DQHD,DQHT,DQHH,DQHB,DTC , DQZY,NAEF,NAED,DQBZ,DQCH,NAEE,DQDH,DQDU,
27	10	NAAN	NAAP,DQEN,DQDR,AZGN,DQEF,DQDW,TDCR,DQEP,NAAA,
28	1	CTAA	
29	1	TDCA	
30	14	TDCN	AZUF,AZXH,AZYC,AZRZ,AZAR,NADU,NADK,NAEH,TYCI,TDCE, TDCC,NACJ,NACK,
31	20	TDCO	DQEK,DQED,DQEL,DQEI,NADR,DQDX,NADT,NADY,NADT,NADS, NACO,NACP,NAEI,NADU,DQDQ,DQUT,NAEJ,TDCF,TDCD,
32	17	TYCF	DQHU,DQHX,DQGB,DQNH,DQBE,DQLX,DQCA,NABQ,TYCC,DQLZ, NABF,AZXJ,AZDA,DQCE,DQDC,DQHK,
33	10	AZJE	NAAJ,AZMJ,AZGE,AZBI,AZJF,AZJI,AZKJ,AZJD,NABO,
34	17	AZPW	NAAL,AZPS,NABE,AZWZ,DQAY,NABP,NACH,DQDY,DQGJ,DQGJ, NADG,NADH,AZPX,NABR,AZPZ,NADQ,
35	20	AZIJ	AZIK,AZJP,AZJA,AZZN,SXGF,SXGR,NAEL,NAEM,SXPA,NADA, AZZJ,TYCG,AZGQ,AZJC,AZJJ,AZIN,NAEY,AZIE,NAEN,
36	17	AZIS	AZIW,AZGM,AZIF,AZII,AZLJ,AZKS,AZIX,AZJK,AZLE,AZLF, NAFA,AZLN,AZIR,NABV,AZIQ,NAAB,
37	17	AZPN	AZPP,AZPL,AZPI,AZGL,AZLK,AZLL,AZLR,NABG,AZKW,AZPC, AZYE,AZXZ,AZLQ,AZPJ,AZPK,AZRB,
38	17	AZWL	NADL,AZAM,AZWJ,AZWK,NAAT,AZWE,AZWF,NABY,NACM,AZSP, AZWB,AZWA,AZSZ,AZND,AZWC,AZSX,
39	14	AZGA	AZQB,AZQC,NAAG,NABM,AZQF,NABN,AZPF,NAEH,AZQE,AZPD,

Table 12-23. Terminal Assignments (Continuation 2)

			AZQD,AZPA,AZKD,
40	20	AZAG	AZQA,AZAG,AZBF,NAET,DQGZ,NAAY,NAAZ,NACH,AZWI,AZWW, NAER,AZZL,AZJZ,AZJO,NADJ,CTAD,AZJP,AZZI,AZZF,
41	15	DTF	DQGI,AZJR,AZJS,AZKK,AZKP,AZKR,AZJW,AZKQ,NABA,AZKN, DQEH,AZKL,NAES,AZKF,
42	16	NAAM	AZGG,AZUR,NACV,NACZ,SXQR,NABW,SXGK,SXRF,NACU,SXBE, NADV,AZZR,NADB,AZZW,AZZX,
43	20	TYCE	AZLA,AZLB,AZTI,AZLC,AZKA,AZLD,NACG,AZKK,AZWR,NAAV, AZWN,AZWP,AZWO,AZWX,AZLI,NAAE,AZZK,AZWS,NAEC,

Table 12-24. Network Option Costs in Thousands of Dollars

Network: TLETS Network with New Data
Remarks: A Single Integrated Network
Number of Regions: 1

Item	No. Reqd.	Recurring Costs: Annual Cost Each	Recurring Costs: Total Annual Cost To 1980	Recurring Costs: Total Annual Cost 1981-1985	Recurring Costs: Eight Year Cost	One Time Installation Costs: Unit Cost	One Time Installation Costs: Total Purchase Cost 1978	One Time Installation Costs: Total Purchase Cost 1981	Total Eight Year Cost by Item
Lines, Modems Service Terminals	-	-	620	634	5,030		38	2	5,070
Terminals	578/596	1.260	729	751	5,942	8.847	5,100	159*	11,201
Regional Switchers									-
Switcher Floor Space									-
Switcher Back up Power									-
Switcher Personnel									-
Engineering									-
Subtotals					10,972	-	5,138	161	16,271
Total Eight Year Cost									16,300

*18 Additional Units

332

Table 12-25. Network Line Characteristics

Network	TLETS with New Data Type	Number of Regions	1
Remarks	Austin as Regional Center		

Line No.	First Node	No. of Terminals	Line Type (Baud)	Line Utilization	Total Mileage (mi)	Mean Response Time (sec)
1	SXLP	10	1200	0.637	73	8.2
2	SXKA	19	1200	0.144	469	4.7
3	SXQP	20	1200	0.179	356	4.8
4	SXRK	19	1200	0.167	433	4.8
5	SXDP	19	1200	0.431	269	6.7
6	AZUE	16	1200	0.201	320	4.9
7	AZTE	17	1200	0.241	0	4.8
8	AZYI	18	1200	0.140	352	4.6
9	NAAN	5	1200	0.020	59	3.9
10	ICRA	1	2400	0.524	0	3.9
11	CTAB	1	2400	0.595	147	2.5
12	CTAC	1	2400	0.486	73	3.4
13	CTAE	20	1200	0.437	374	6.3
14	TDCK	20	2400	0.638	156	5.7
15	BPPA	1	2400	0.390	0	3.2
16	TYCA	19	1200	0.305	313	5.6
17	AZUS	13	1200	0.168	143	4.6
18	AZUX	13	1200	0.153	176	4.6
19	AZBN	14	1200	0.063	255	4.2
20	DQHT	20	1200	0.308	297	5.6
21	DTJ	1	4800	0.472	181	2.2
22	DQSU	16	1200	0.296	181	4.8
23	DQJH	16	1200	0.090	394	4.4
24	DQGY	19	1200	0.136	451	4.6
25	DQJT	12	1200	0.122	254	4.4
26	DQKT	19	1200	0.316	213	5.6
27	NAAW	10	1200	0.250	278	5.0
28	CTAA	1	4800	0.668	181	2.9
29	TDCA	1	2400	0.375	134	3.2
30	TDCN	14	1200	0.427	279	6.5
31	TDCO	20	1200	0.421	473	6.6
32	TYCF	17	1200	0.161	369	4.7
33	AZJE	10	1200	0.185	549	4.7
34	AZPW	17	1200	0.065	356	4.3
35	AZIJ	20	1200	0.136	698	4.7
36	AZIS	17	1200	0.082	523	4.4
37	AZPN	17	1200	0.129	550	4.6

Table 12-25. Network Line Characteristics (Continuation 1)

Network TLETS with New Data Type — Number of Regions 1
Remarks Austin as Regional Center

Line No.	First Node	No. of Terminals	Line Type (Baud)	Line Utilization	Total Mileage (mi)	Mean Response Time (sec)
38	AZWL	18	1200	0.170	661	4.8
39	AZGA	14	1200	0.082	386	4.3
40	AZAG	20	1200	0.457	1078	6.5
41	DTF	15	1200	0.080	446	4.3
42	NAAM	16	1200	0.051	317	4.2
43	TYCE	20	1200	0.135	623	4.6

Table 12-26. Compilation of Cost and Performance Data for Texas Options 1 Through 5

Item	Option	1	2	3	4	5
	Network	1 Region	2 Region	3 Region	Separate TLETS, New Data	TLETS plus New Data
Item	**Parameter**					
1	One Time Cost ($K)	5.2	5.3	5.2	5.6	5.2
2	Eight Year Recurring Cost ($K)	10.6	11.8	13.3	11.6	11.0
3	Response Time (sec)	5.0	5.0	5.0	5.0/ 15.0*	6.7
4	Availability	0.979	0.973	0.973	0.979	0.979

*15.0 on separate New Data Network

SECTION 13

STACOM/TEXAS NETWORK COMPARISONS

This section provides a comparative overview of the five STACOM/TEXAS Network Options and also presents results of three additional studies. One additional study assesses the impact on network costs of reducing response time at terminals to less than the 9 seconds called for in the STACOM/TEXAS Functional Requirements. A second study deals with impacts on the TLETS network due to inclusion of classified fingerprint data. The third additional study investigates the potential for line savings if network multidropping is carried out without the restriction of serving C.O.G. agencies on separate lines.

13.1 COMPARISON OF THE THREE TLETS OPTIONS

Each of the three TLETS options, Options 1 through 3 involving the use of 0 to 2 regional switchers, in addition to the existing Austin Switcher, have been designed to meet or exceed STACOM/TEXAS Functional Requirements. The principal issue of comparison between networks thus becomes cost. Costs presented here, and in the previous Section 12, are based upon total eight-year installation and recurring costs for the year 1978 through 1985 as developed in Section 9.

Figure 13-1 presents total eight-year costs for Options 1, 2 and 3. The single region TLETS network is the least expensive. The best two region case with switchers in Austin and Dallas, and the best three region case with switchers in Austin, Dallas and San Antonio follow with increasing total costs.

The network with the least recurring line costs is the three region Austin, Dallas, Houston configuration (see Section 12). The network with the greatest recurring line cost is found in the three region Austin, Dallas, San Antonio case. However, the latter case exhibits lowest overall costs for three regions, since the eight-year difference in line costs does not justify the movement of switchers.

In any case, the single region network is the least cost network. These results show that line savings due to the use of regional switchers located throughout the state do not offset the additional costs incurred for regional switcher hardware, sites, personnel, interregion lines and increased engineering costs encountered in a more complex network.

Since all networks meet functional requirements, the conclusion is that the STACOM/TEXAS single region network is the most cost-effective option of the first three options.

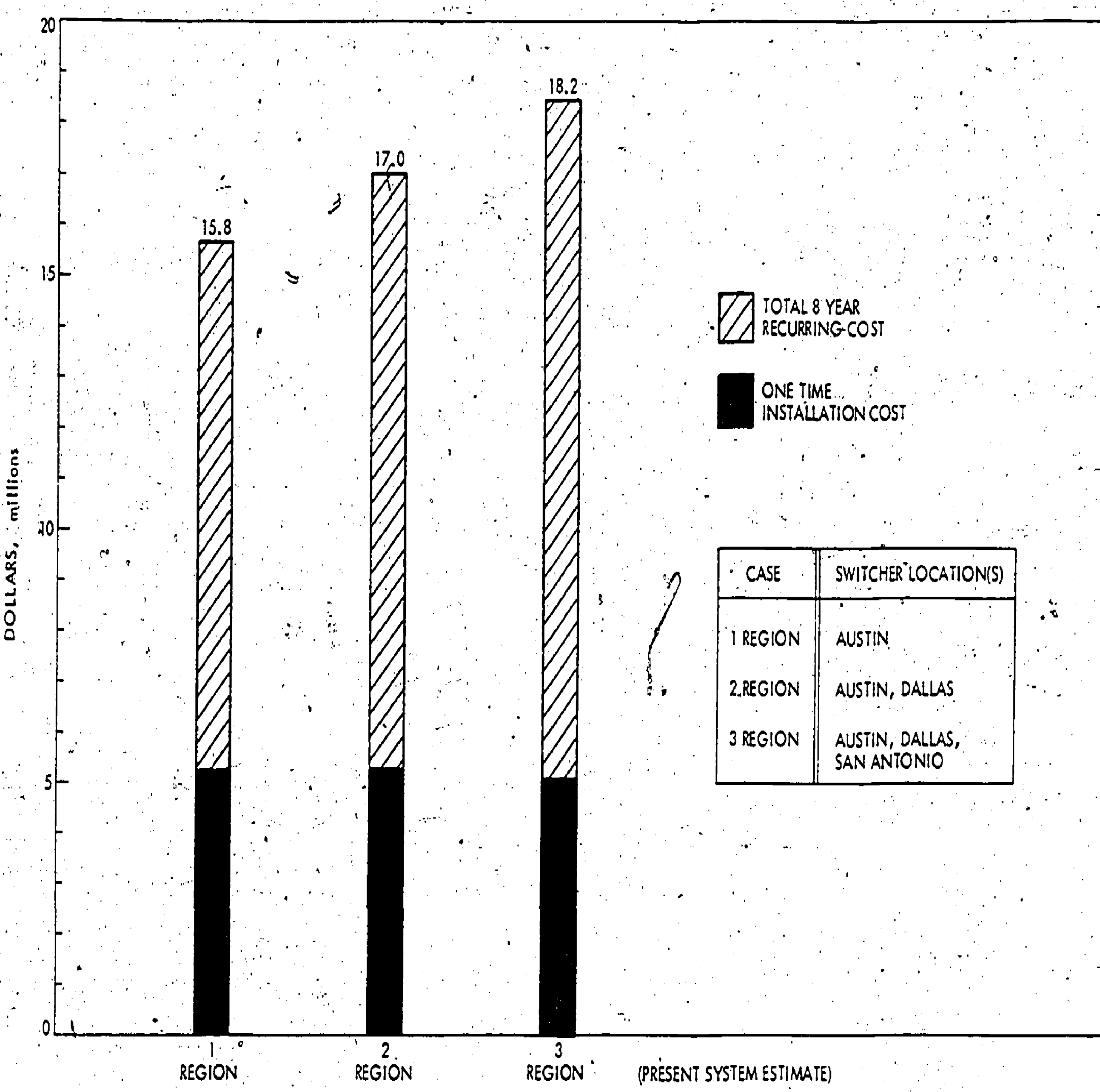


Figure 13-1. Total Comparative Cost 1978 Through 1985
Options 1 Through 3

13.2 SEPARATE VS INTEGRATED TLETS/NEW DATA NETWORK(S)

Whether integrated with the TLETS Network or not, the estimated growth of new data types from the present until 1985 calls for the implementation of 14 terminals through 1980 and the addition of 18 more terminals in 1981, for a total of 32 operational terminals from 1981 through 1985. This means that in either case there is an additional one-time installation cost incurred in 1981.

When installation and recurring costs are totaled over an eight-year period for the separate and integrated configuration, the costs are as shown in Figure 13-2.

If the TLETS and New Data networks were to be implemented as two separate networks, the total eight-year comparative cost is $17,150,000, or approximately 17.2 million as shown. If network lines are integrated in accordance with Option 5, the total cost is $16,300,000. The eight year estimated difference is $850,000.

The monetary benefits of integration over an eight-year period are significant enough to come under consideration in the management decision to implement Options 4 or 5.

Mean response time requirements are met in the integrated network without a need for message prioritization.

13.3 NETWORK COST SENSITIVITY TO RESPONSE TIME

The effect of reducing network response time on annual recurring costs for lines, modems and service terminals in the single region TLETS case, (Option 1), was investigated. Network optimization computer runs were carried out at a number of points where the required response time was set at less than 9 seconds. The program then found the required networks and produced costs for each run.

Figure 13-3 shows the results of this analysis, which was carried out with the same mean service times for the Austin Switcher and Data Base Computers used in Option 1 runs to clarify the effect on network costs. The figure shows that for the STACOM/TEXAS single region TLETS network, there is virtually no cost penalty for specifying a response time down to approximately 7.0 seconds. Stating the case alternatively, a network that meets a 9.0 second response time requirement also meets a 7.0 second requirement.

A slight increase in cost begins to appear at 6.0 seconds, due primarily to the reduction of the number of multidropped terminals on some of the lines. This reduction is required to meet the lower response time goal.

A substantial increase in cost of about 10% is required to realize a reduction in response time from 6.0 to 5.0 seconds. Reductions in mean response time requirements below 5.0 seconds begin to result in rapidly increasing costs.

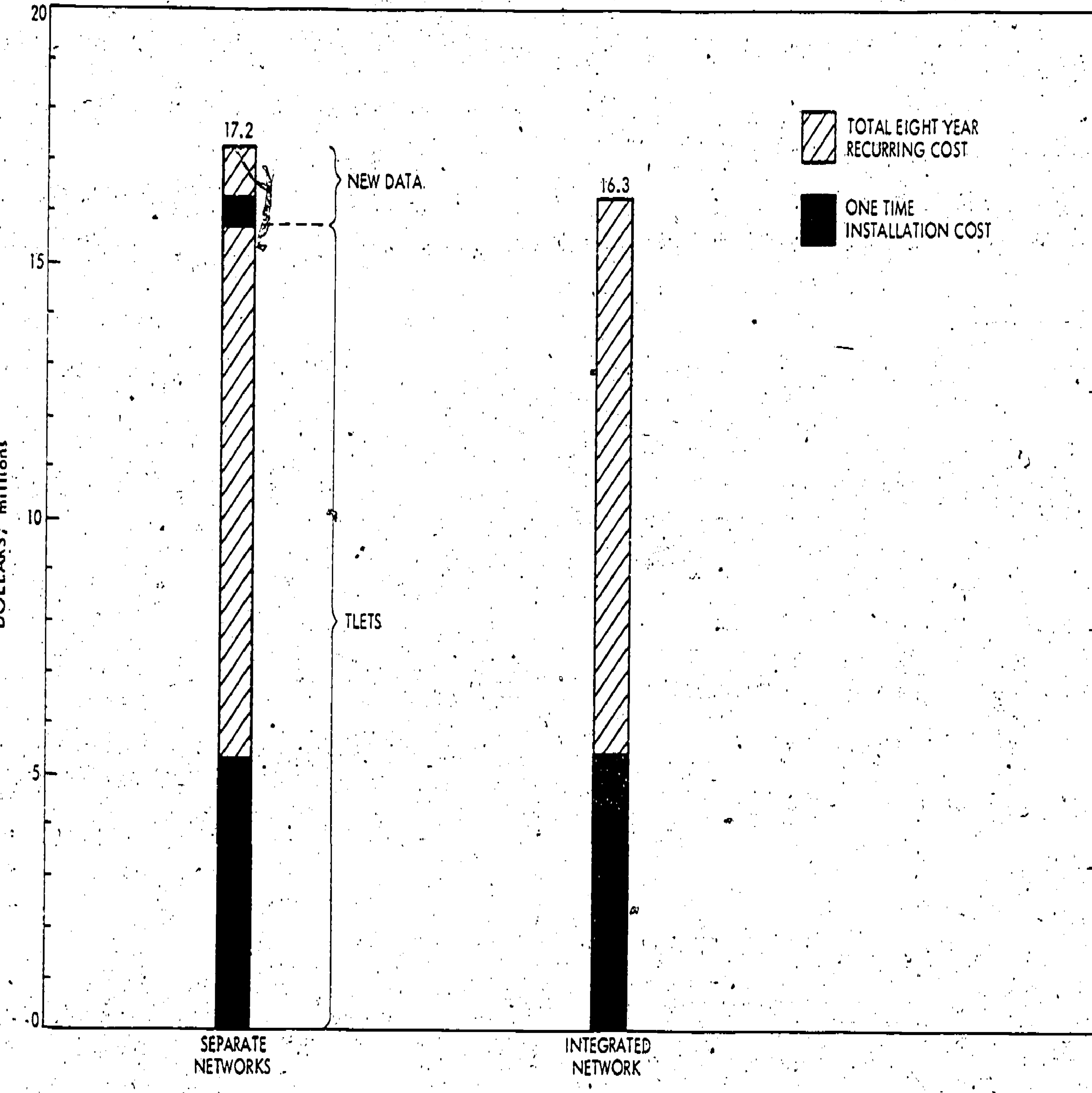


Figure 13-2. Eight Year Comparative Costs Separate and Integrated TLETS/New Data Networks

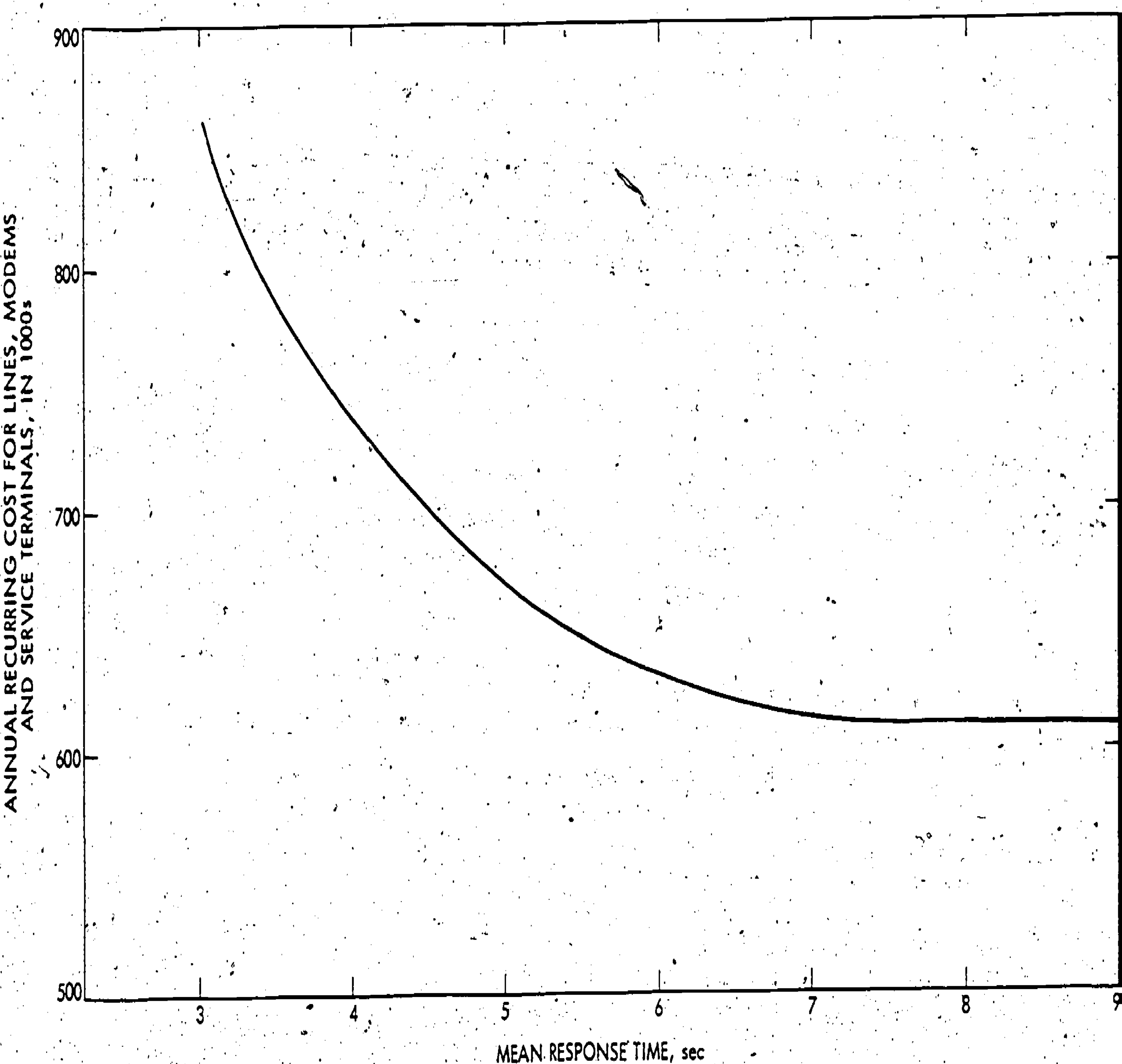


Figure 13-3. Recurring Annual Line Costs vs Mean Response Time -- TLETS Single Region

13.4 IMPACT OF FINGERPRINT DATA ON LEADS/NETWORK

13.4.1 Topology

Predicted growth of fingerprint data types is contingent on the development and use of digitizer and classifying equipment located in major Texas cities. The STACOM Study implementation schedule calls for a first digitizer/classifier to be located in the Dallas-Ft. Worth area in 1981 and three more to be added to the system in 1983 at Houston, San Antonio and El Paso. The incorporation of these facilities involves a slight modification to the topology of the single region TLETS case, (see section 12.2). The TLETS Network with fingerprint data added as specified requires a total of 36 multidropped lines. These lines, and their principal characteristics, are summarized in Table 13-1.

13.4.2 Costs

Total eight-year costs for a TLETS Network which handles fingerprint data are broken down in Table 13-2. Costs for the TLETS System from 1978 to 1985 are shown separately. In 1981, the incremental costs for the first terminal in Dallas are shown. These costs are incurred through 1985. The three-year costs for the addition of the final three terminals in 1983 through 1985 are also listed.

Total eight-year costs are $16,537. Costs for lines, modems, and service terminals, (listed as LINES in Table 13-2), account for about 8% of the eight-year cost increase over the single region LEADS without fingerprints and the costs for fingerprint processing equipment accounts for 92% of the additional cost.

As indicated in Table 13-2, the purchase cost for a single fingerprint digitizer-classifier is estimated at $200,000 per unit. Annual maintenance is assumed to run at $12,000.

13.4.3 Performance

The principal performance question of interest when considering the addition of messages with long average message lengths, such as fingerprint data, to the TLETS Network is the potential degrading effect on response times for higher "priority" type messages involving officer safety.

An analysis of the mean and standard deviation of message service times on the TLETS Network with fingerprint data added, indicates that mean response time goals specified in the STACOM/TEXAS Functional Requirements will be met satisfactorily without the necessity of message prioritization by the computer.

This result stems from two considerations. First, the classification of fingerprint data allows for substantial reductions in the actual amount of data characters transmitted for each fingerprint (1852 characters). Second, while this message length is still

Table 13-1. Network Line Characteristics

Network TLETS with Fingerprint — Number of Regions 1
Remarks Austin as Regional Center

Line No.	First Node	No. of Terminals	Line Type (Baud)	Line Utilization	Total Mileage (mi)	Mean Response Time (sec)
1	SXLP	10	1200	0.640	73	9.0
2	AZID	20	2400	0.608	154	5.0
3	AZFI	17	1200	0.156	313	4.4
4	SXKA	19	1200	0.144	469	4.4
5	SXQP	19	1200	0.069	344	4.1
6	SXRK	19	1200	0.168	433	4.5
7	AZUE	16	1200	0.202	320	4.6
8	SXGC	18	1200	0.121	350	4.5
9	AZTE	20	1200	0.247	70	4.9
10	AZUN	18	1200	0.100	304	4.2
11	FPAB	1	2400	0.545	147	3.5
12	FPAC	17	1200	0.528	375	6.4
13	AZUS	11	1200	0.083	143	4.0
14	AZUX	17	1200	0.114	396	4.2
15	AZBN	14	1200	0.064	255	4.0
16	DQHT	20	1200	0.309	297	5.2
17	DTJ	17	4800	0.549	181	2.7
18	DQHU	10	1200	0.094	309	4.0
19	DQEK	17	1200	0.076	441	4.1
20	AZXJ	16	1200	0.145	286	4.3
21	DQGY	19	1200	0.136	451	4.4
22	DQJT	12	1200	0.123	254	4.2
23	DQKT	19	1200	0.318	213	5.3
24	AZUF	19	1200	0.095	449	4.2
25	FPAA	1	2400	0.626	181	3.9
26	AZPW	17	1200	0.065	356	4.1
27	AZIJ	19	1200	0.124	698	4.3
28	AZLA	19	1200	0.053	623	4.1
29	AZIS	17	1200	0.083	523	4.1
30	AZPN	17	1200	0.136	550	4.3
31	AZWL	18	1200	0.171	661	4.5
32	AZGA	14	1200	0.083	386	4.1
33	AZAG	9	1200	0.437	706	6.0
34	DTF	15	1200	0.080	446	4.1
35	AZBF	11	1200	0.025	489	3.8
36	NAAM	16	1200	0.051	317	4.0

Table 13-2. Cost Summary by Year for TLETS Network with Fingerprint Data in Thousands of Dollars

Year(s)	Item	Number Required	Annual Cost Each	Total Annual Cost	Eight-Year Recurring Cost	Unit Cost	Total Purchase Cost
1978-1985	Lines	-	-	615	4,928	-	37
	TLETS Terminals	564	1.260	711	5,700	8.847	5,000
1981-1985	Lines*	-	-	3.2	16	-	.22
	Fingerprint* Terminals	1	12	12	60	200	200
1983-1985	Lines*	-	-	5	15	-	1
	Fingerprint* Terminals	3	12	36	108	200	600
					10,827		5,838
				Total Eight Year Cost			16,665

*Added Costs in Years Shown

comparatively long with respect to the normal TLETS message types, the occurrence of fingerprint messages on the network accounts for only about 1% of the total traffic predicted for 1985.

For these reasons, the mean response time goal of less than, or equal to 9 seconds is met for the network topology presented above.

13.5 LINE SERVICE TO COUNCIL OF GOVERNMENTS

In the present TLETS system, multidropped lines providing service to agencies throughout the state are organized such that single multidrop lines service agencies in jurisdictions of a single Council of Governments (COG).

A study was carried out to compare costs of the single region TLETS network, (Option 1), in which multidropped lines were not restricted to servicing single C.O.G. areas only, and costs for a single region TLETS network in which multidropped lines were organized to service single COGs.

The resulting COG-oriented network is shown in Figure 13-4. Annual recurring line costs for this network amount of $617,000 as compared with $611,000 for the unrestricted multidropping Option 1 case. Since all other network costs are comparable, the difference of $6,000 per annum over eight years amounts to $48,000. This difference is not considered significant when compared to overall network costs. The result is that significant cost savings are not to be realized in the abandonment of a COG oriented approach.

Performance characteristics for the network pictured in Figure 13-4 are presented in Table 13-3.

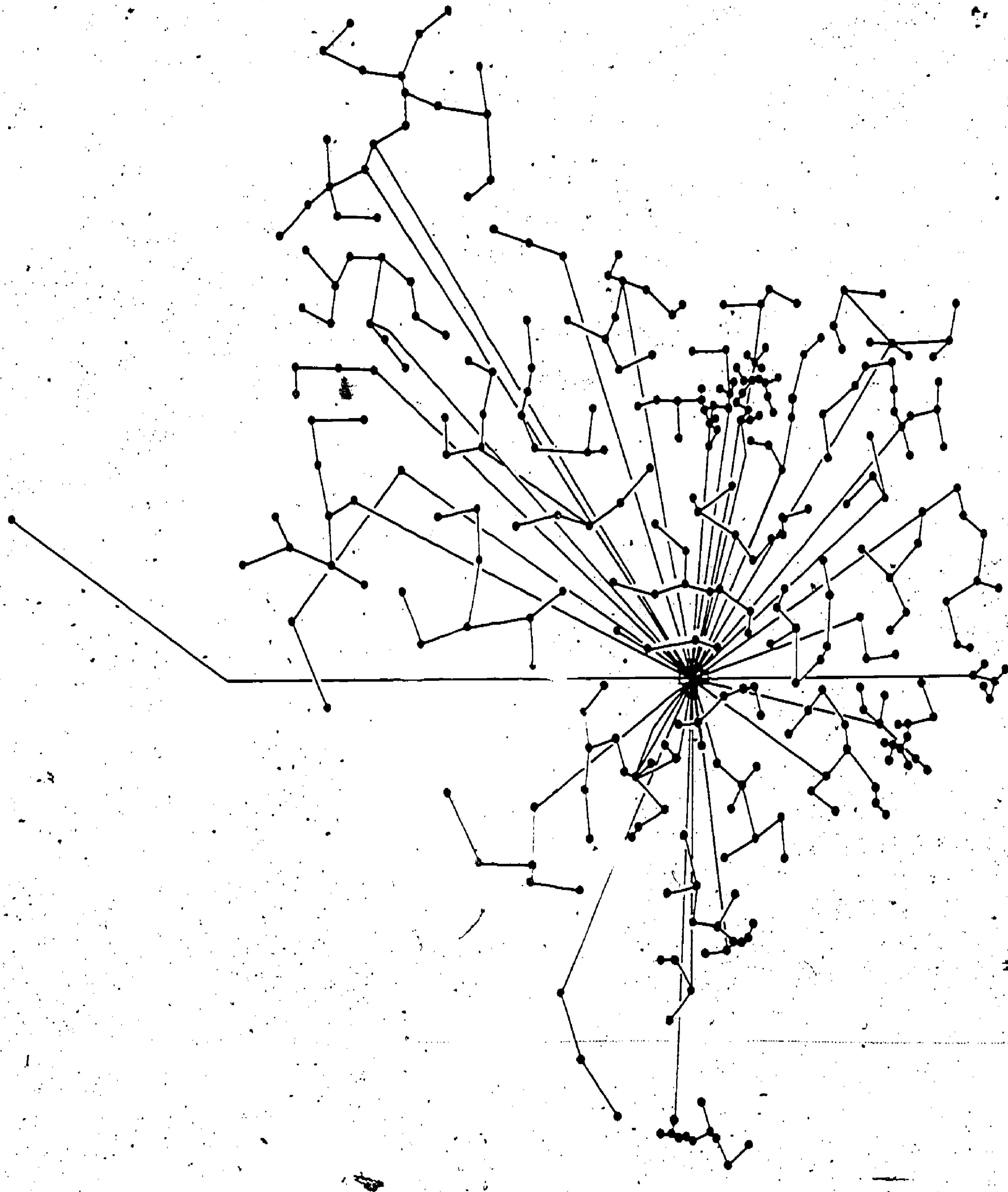


Figure 13-4. TLETS Single Region COG Oriented Network

Table 13-3. Network Line Characteristics

Network Remarks: TLETS Under COG Structure Austin as Regional Center — Number of Regions: 1

Line No.	First Node	No. of Terminals	Line Type (Baud)	Line Utilization	Total Mileage (mi)	Mean Response Time (sec)
1	S	1	2400	0.302	73	2.6
2	AZZD	20	1200	0.102	305	3.9
3	NACA	8	1200	0.030	96	3.5
4	NAEG	17	1200	0.095	491	3.9
5	NAEO	13	1200	0.059	261	3.7
6	AZRI	17	1200	0.243	0	4.5
7	NAAP	8	1200	0.025	128	3.5
8	NAEW	5	1200	0.011	107	3.4
9	AZUS	17	1200	0.119	245	4.0
10	SXBP	7	1200	0.052	247	3.5
11	SXBJ	18	1200	0.173	358	4.2
12	AZAG	12	1200	0.074	469	3.7
13	DQDR	18	1200	0.083	506	3.9
14	DQEK	20	1200	0.104	448	4.0
15	NAAX	8	1200	0.077	264	3.6
16	NABX	14	1200	0.067	224	3.7
17	AZXR	15	1200	0.127	249	3.9
18	AUB	1	2400	0.495	147	3.4
19	AZHN	20	1200	0.241	196	4.5
20	AZIB	18	1200	0.157	308	4.1
21	AZYC	6	1200	0.053	185	3.5
22	NAEQ	18	1200	0.098	317	3.9
23	SXRL	18	1200	0.163	399	4.1
24	NAEK	12	1200	0.048	323	3.6
25	DQHT	28	1200	0.310	297	4.9
26	DTJ	1	2400	0.472	181	2.2
27	DQSU	16	1200	0.296	181	4.7
28	AZDA	10	1200	0.061	280	3.6
29	DQJT	18	1200	0.243	261	4.5
30	DTQ	20	1200	0.266	298	4.6
31	AZJS	15	1200	0.081	453	3.8
32	NAET	6	1200	0.017	365	3.4
33	AZWJ	20	1200	0.104	789	4.0
34	NADL	12	1200	0.098	579	3.8
36	AZIW	5	1200	0.024	444	3.4
37	AZII	20	1200	0.130	561	4.1
38	AZDU	11	1200	0.156	270	4.0
39	AZLL	18	1200	0.138	617	4.1

Table 13-3. Network Line Characteristics (Continuation 1)

Network	TLETS Under COG Structure	Number of Regions	1
Remarks	Austin as Regional Center		

Line No.	First Node	No. of Terminals	Line Type (Baud)	Line Utilization	Total Mileage (mi)	Mean Response Time (sec)
40	AZKS	6	1200	0.017	388	3.4
41	SXRD	5	1200	0.047	307	3.5
42	DQBE	8	1200	0.060	304	3.6
43	AZPW	18	1200	0.050	462	3.8
44	NAAL	14	1200	0.082	355	3.8
45	NAAV	10	1200	0.187	549	4.1

348

SECTION 14

REFERENCES

3-1 Crime in the United States - Uniform Crime Reports, U.S. Government Printing Office, Washington, D.C., 1974.

3-2 National Criminal Justice Telecommunications Requirements, JPL Report 1200-133, Rev. A, June 28, 1974.

3-3 Joseph P. Martino, Technological Forecasting for Decisionmaking, American Elsevier Publishing Company, Inc., New York, 1972.

3-4 N. R. Draper and H. Smith, Applied Regression Analysis, John Wiley & Sons, Inc., New York, 1966.

SECTION 15

BIBLIOGRAPHY

1. An Analysis of Automated and Semi-Automated Systems for Encoding and Searching Latent Fingerprints, Technical Memorandum No. 9, Project SEARCH, Sacramento, Calif., March 1974.

2. Annual Report of Texas Judicial Council, Texas Judicial Council, Austin, Texas, Annual.

3. Biomedical Computer Programs, University of California Press, Berkeley and Los Angeles, Calif., 1975.

4. Bright, James R. and Schoeman, Milton E. F., A Guide to Practical Technological Forecasting, Prentice Hall, Inc., Englewood Cliffs, New Jersey.

5. Crime in the United States - Uniform Crime Reports, FBI, U.S. Government Printing Office, Washington, D.C., Annual.

6. Criminal Justice Models: An Overview, NILECJ, LEAA, U.S. Dept. Of Justice, Washington, D.C., April 1976.

7. Directory of Automated Criminal Justice Information Systems, U.S. Dept. of Justice - Law Enforcement Assistance Administration, Dec. 1972.

8. Draper, N. R., and Smith, H., Applied Regression Analysis, John Wiley & Sons, Inc., New York, 1966.

9. Felkenes, George T. and Whisenand, Paul M., Police Patrol Operations, McCutchan Publishing Corporation, Berkeley, Calif., 1972.

10. Martino, Joseph P., Technological Forecasting for Decisionmaking, American Elsevier Publishing Company, Inc., New York, 1972.

11. National Criminal Justice Telecommunications Requirements, JPL Report 1200-133, Rev. A., June 28, 1974.

12. OBSCIS: The OBSCIS Experience, Technical Report No. 16, SEARCH Group, Inc., Sacramento, Calif., Nov. 1976.

13. OBSCIS: Volume 1, The OBSCIS Approach, Technical Report No. 10, SEARCH Group, Inc., Sacramento, Calif., May 1975.

14. Ohio Courts Summary, Ohio Administrative Director of Courts, Columbus, Ohio, Annual.

15. Report on Latent Fingerprint Identification Systems, Technical Memorandum, No. 8, Project SEARCH, Sacramento, Calif., March 1974.

16. SJIS: Final Report (Phase I), Technical Report No. 12, SEARCH Group, Inc., Sacramento, Calif., June 1975.

17. SJIS: Final Report (Phase II), Technical Report No. 17, SEARCH Group, Inc., Sacramento, Calif., Sept. 1976.

18. Standards for Security and Privacy of Criminal Justice Information, Technical Report No. 13, SEARCH Group, Inc., Sacramento, Calif., Oct. 1975.

19. U.S. Statistical Abstracts, U.S. Government Printing Office, Washington, D.C., Annual.

20. Esau, L. and Williams, K., "On Teleprocessing System Design: Part II-A, Method for Approximating the Optimal Network," IBM System Journal, Vol. 5, No. 3, 1966.

21. Barlow, R. and Proschan, F., Statistical Theory of Reliability and Life Testing Probability Models, Holt, Rinehart and Winston, Inc., 1975.

APPENDIX A

STACOM PROJECT
STATE LEVEL QUESTIONNAIRE

1) Please provide one diagram showing principal components used in information interchange between all criminal justice user agencies. Principal components are defined as:

Data Bases

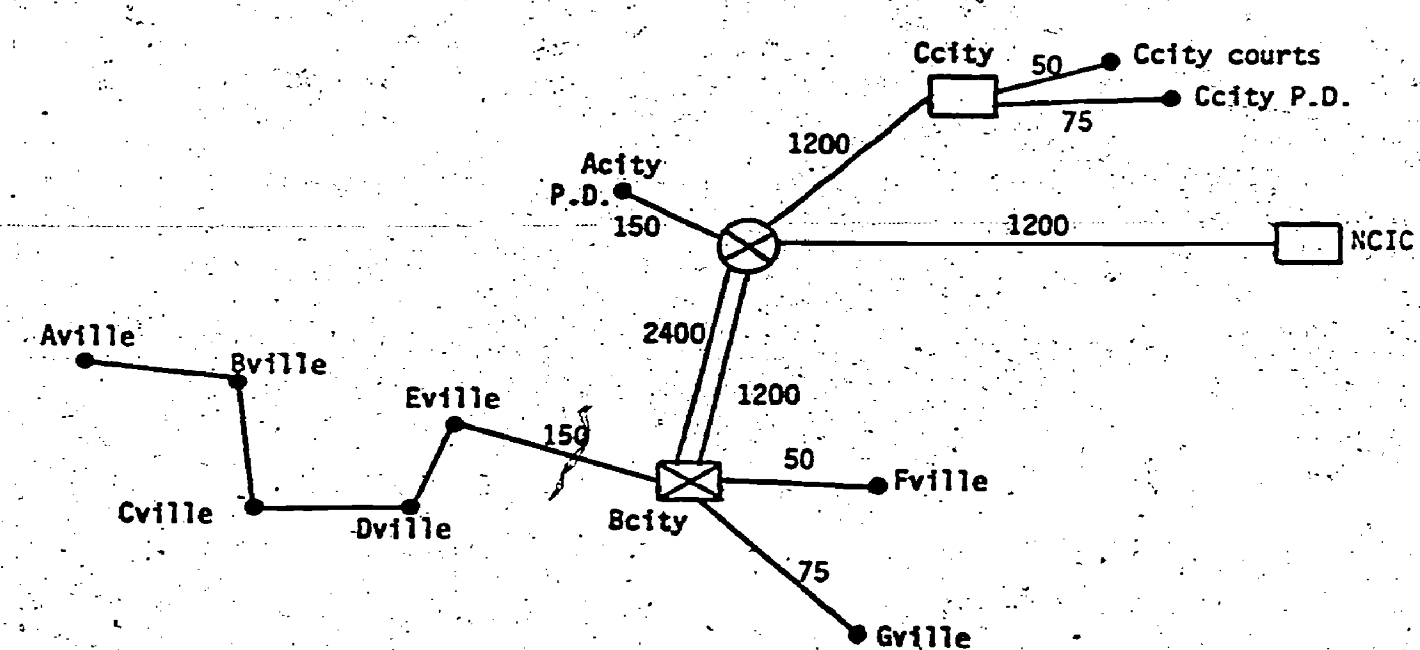
Switchers/Concentrators

Data Base and Switcher

Terminal(s)

Line

Please include line sizes in bauds. For example:



Please indicate system upgrades that have occurred since January 1971 and indicate when they have occurred. Also, please indicate system upgrades that are planned for the future. Make separate diagrams if necessary.

2) Please provide the information requested below regarding your state criminal justice information system.

	1971	1972	1973	1974	1975	1976
Number of Records in						
File Type 1						
File Type 2						
.						
.						
.						
File Type N						

3) Please supply past traffic volume data covering the period 1971 to the present. These traffic statistics should be broken out by user agency and message type.

351

4a) Please provide format details for all message types transmitted over your state criminal justice communications system.

4b) Please provide average message lengths by message type.

5) Please provide an origin and destination matrix showing yearly message volumes from each user agency to each other user agency in your state.

6) Are there instances where a query into one data file will automatically generate queries into other data files? If so please describe this process.

7) Please indicate any planned upgrade that would affect traffic against current law enforcement files. Examples are:

a) Increase the number of records in file.

b) Reduce response times.

c) Increase the number of law enforcement users.

8) The following is a list of 'new' data types

- computerized criminal histories - already in service
- offender-based transaction statistics (adult and juveniles)
- criminal court audit and management systems
- criminal justice planning information
- criminal intelligence data
- crime lab data including facsimile transmission, bibliographic exchange, firearm identification and spectral analysis
- corrections agency data systems (for management, training, education and rehabilitation which includes parole, probation, and corrections departments)
- criminal extradition and rendition system
- prosecutors management information system
- automated legal research
- video applications (including training, courts and corrections)
- digital mug shot identification
- digital fingerprint transmission
- boat registration file maintained by Parks and Wildlife Dept.

Include in this list others you are aware of.

8a) In your answers to questions 2) and 3) you have supplied us with information concerning data base characteristics and message volumes for the above 'new' data types already implemented on your state telecommunication system. For each of these already implemented new data types:

1) Do you plan to increase the number of records contained in the data files? If yes please discuss the phasing of this increase.

2) Will the number of users participating in the exchange of these new data types increase? If yes, please identify the new users.

8b) With respect to each of the 'new' data types in the list above which you have not yet implemented.

1) Is implementation planned? If yes

2) What is the time phasing?

3) What agencies will use it?

4) Which facilities will maintain data bases with this data type?

5) Is any state agency studying or testing the feasibility of one of these data types? If so, describe.

8c) With respect to all of the above new data types, are you aware of, or are you using, any new or recent commercial product or service which is specifically tailored to acquire, process, or display this data type. An example might be a special purpose fingerprint analysis and display terminal which sends and receives digitized fingerprint data.

9a) Please identify either federal or state privacy and security legislation that currently has an impact on the criminal justice information system, with regard to such things as data file update intervals, encryption requirements, personnel identification at the terminals, dedicated vs. shared systems, fingerprints supporting each file, etc. Please characterize these impacts.

9b) Are you aware of planned privacy legislation that will impact criminal justice information systems? If yes, please characterize these impacts.

10) Please identify administrative and legislative constraints to system development.

1) Regionalization within your state.

2) Requirements to utilize existing state equipment.

3) Interrelationships between state criminal justice agencies which may impede development of an integrated criminal justice telecommunication system.

4) Budget limitations

11) Are there other innovations or planning activities in the state that would aid us in predicting traffic levels? Examples are:

a) Are you in contact with and aware of the local Bell System operating company's (or other common carrier's) planning activities for your state? If so, please describe.

b) Are you in contact with the State Public Utilities Commission and maintain currency with their decisions on state tariffs and other related communication matters? If so, please explain the nature of your contact.

c) Can you provide descriptive material of the state's organizations dealing with telecommunications in general, and criminal justice telecommunications in particular?

12a) Has a criminal justice flow model been prepared that describes the offender's progress through your state's criminal justice system?

12b) Has the information needed to perform functions in the above flow process been identified? We are specifically interested in information that could be transmitted over the state criminal justice information system.

13) Please provide information on the number of criminal justice agencies in your state by agency type.

Agency Type	Number
Law Enforcement	
Courts	
Corrections	

14) Please provide the following court statistics.

1) Number of courts by type.

2) For each court type.

Number of Yearly Filing by Case Type

a) Case Type/Year 1972 1973 1974 1975

Number of Dispositions by Case Type

b) Case Type/Disposition, e.g., Conviction Acquittal Lesser Charge

3) Are there factors in the future that are likely to change these statistics?

a) Normal Growth

b) Decriminalization

c) Administrative Changes

d) Etc.

APPENDIX B

STACOM PROJECT
USER AGENCY SURVEY

USER AGENCY ______________________________

ADDRESS ______________________________ DATE ______________

______________________________ RESPONDENT ______________

PHONE ______________

AVG. NO. OF MSG. SENT/DAY ______________________________

AVG. NO. OF MSG. RECEIVED/DAY ______________________________

NO. OF MSG. SENT DURING PEAK HR ______________________________

CURRENT AVERAGE RESPONSE TIME* (sec) ______________________________

ACCEPTABLE RESPONSE TIME (sec) ______________________________

PERCENTAGE DOWN TIME ______________________________

Please fill out as much as you can in the following table for the population area served by your terminal.

	1975	1974	1973	1972	1971
Crime Rate per Capita**					
Number of Personnel Requiring Info. over State C.J. Tele-communications System					

*Your best estimate of average response time. Response time is defined as time from the moment you request the network to take a message until a satisfactory reply is completed at your terminal.

**Includes crimes falling in the U.C.R. seven major crime categories. Murder and non-negligent manslaughter, forcible rape, robbery, aggravated assault, burglary - breaking or entering, larceny and auto theft.

☆ U.S. GOVERNMENT PRINTING OFFICE : 1978—O-260-992